The Science Teacher

SPIDER AND WEB

(Courtesy Professor John G. Albright See Page 14)

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THE SCIENCE TEACHER

Official Journal of

National Science Teachers Association

A *Scientific and Professional Association*

Associated with American Association for Advancement of Science

A Department of the National Education Association

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The Science Teacher

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The Science Teacher

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X-Ray Diffraction Testing and Research in Wartime Chemical Industry

BY GEORGE L. CLARK

Professor of Chemistry University of Illinois, Urbana, Illinois

ON NOVEMBER 8, 1945, there will be celebrated, let us hope by a grateful world at peace, the fiftieth anniversary of the discovery of X-rays by Wilhelm Conrad Roentgen. When peace is declared X-rays will continue to do battle as they have for fifty years—to save life from the ravages of cancer. Roentgen had only the faintest idea that X-rays might have value outside of the fields of pure physics and medicine. Perhaps, he did visualize routine radiographic inspection of metallurgical specimens for gross defects where failure might result in the loss of human life. But, it was 1912 before diffraction of X-rays by single crystals was proved by Von Laue and 1916 before the powder method of analysis was anunounced by Hull in the United States and Debye and Scherer in Switzerland. In the ensuing thirty years there has been a slow, but steady progress in the application of this fundamental method to the problems of chemistry and industry until the challenge of the present war has swept diffraction testing and research into a position of general recognition. It is safe to say that when the results on war materials can be released there will be positive amazement at the practical achievements of a technique which was for so long of purely academic interest.

The fundamental principles of the diffraction of X-rays by crystalline materials and of the interpretations of the so-called diffraction patterns which are photographed on films in terms of the ultimate atomic and molecular architecture of the materials are generally familiar through many books and scientific papers. A crystal is simply a three-dimensional regular repeating plan of a motif—an atom or molecule or group—just as wall-paper may present a two-dimensional repeating plan of a motif or figure. Through such a lattice-work of parallel equidistant planes passing through these regularly arranged atoms or molecules may be imagined in an infinite number of directions though only a few of these sets of planes are very thickly populated with the constituent atoms or molecules. These planes spaced a few hundred millionths of a centimeter apart (1×10^{-8} cm. or 1 Angstron unit) constitute a 3-dimensional diffraction grating for X-rays with a compatible wave length of a few Angstron units just as finely ruled parallel lines on glass or metal are a diffraction grating for light and thereby produce a spectrum. The basic law of X-ray diffraction is then the familiar Bragg law: $n\mu = 2d \sin\theta$, where n is an integer, μ is the X-ray wave length (usually known), d is unknown the spacing of one set of planes in the crystal (for example, the planes parallel to a cube face in rocksalt), and θ is the angle of incidence of the X-ray beam on this set of planes, or 2θ, which is experimentally measured, is the angle of diffraction of the ray from these planes.

NOW there are several techniques of X-ray diffraction, depending on the type of specimen—that is, whether it is a single crystal, a powder composed of a multitude of very small crystals heaped together at random, or a fiber with many grains lined up in a preferred direction. But all methods involve the Bragg Law, and the measurement of a considerable number of d values, either registered from a single set of planes at a time on one film, or simultaneously from a large number of different sets of planes as is true for a random array of crystals in a powder. From relationships between a series of such d values

for any crystal, the unit crystal cell dimensions are deduced, these being absolutely characteristic of each kind of crystal, along with the number of atoms of molecules belonging to this ultimate unit. Then by a consideration of the intensities of the various diffraction interferences from many sets of planes and of the laws of optical interference, the actual positions of the atoms within molecules may be derived and even a contour map (of electron densities) of the crystal drawn as projected on a plane. This is the final step in the unique analysis of crystal architecture, usually possible only with single perfect crystals. Such an analysis derived from diffraction patterns must lead to an explanation of all the properties of the crystal. The diffraction pattern is necessarily uniquely characteristic of the crystal and of the chemical composition of the crystal. Hence, the pattern is the "finger print" which non-destructively identifies the substance in its given crystalline form. This is the primary industrial use of X-ray diffraction in chemical industry, almost always by the powder method, since there are very few industrial processes involving single crystals. An outstanding exception in the preesnt war is the X-ray diffraction control of production of piezoelectric quartz crystals used for radio frequency control by the U. S. Army Signal Corps. The grinding and alignment of crystal planes is entirely determined by the diffraction patterns reflected backward from the face of the specimen. Hundreds of such X-ray spectographs are in use.

In addition to crystalline (and thus chemical) identification from diffraction patterns, there is also the evaluation of the peculiar *texture* of the specimen under investigation—whether it is really crystalline or is amorphous or like a glass; whether it is a single crystal, a random aggregate or fiber; the grain size, especialy of the material is colloidal; and the presence of absence of strain. The last is, of course, most important for metals and alloys, but the other details of texture are often of utmost importance in the chemical industry.

WHILE this paper is primarily concerned with the applications of X-ray diffraction in the inorganic chemical industry, it is of interest to list some of the most important examples of industrial use before describing specific examples in the field of immediate concern.

1. Metals and Alloys. As expected this is the largest and most fruitful field for structure analysis, especially on war problems. X-ray diffraction results have solved problems of stress and strain in magnesium and aluminum alloys in airplane motors; armor-piercing shells; new alloys; optimum heat-testing and quenching procedures of all kinds; specifications and behavior in powder matellurgy; drawing, forging and rolling operations; ore analysis and specifications; special steels for enameling; metal films and mirrors; the bonding of electrodeposited layers in some of the most important commercial platings (see Clark, Pish, and Weeg, Journal of Applied Physics, 15, 193, Feb. 1944); brass and alloy recrystallization; and in general, scores of problems involving uniform production and optimum properties.

2. Polymers. The contribution to the knowledge of structure of synthetic rubber of many varieties (particularly in comparison with natural rubber which must be replaced) and of the vast array of new plastics, resins, varnishes, celluloses, starches, and proteins is now immeasurably great. Much of this information is still confidential. Some of the most important plastics have been synthesized with X-ray diffraction as a guide to mechanism, molecular length, rate of formation, and stability.

3. Organic Chemicals and Drugs. Identification of compounds by comparison with standard X-ray patterns, while not yet so well developed as in the inorganic field, is frequently accomplished by the Dow, du Pont, General Aniline and Film, Hercules, American Cyanamid, Eastman Kodak and many other manufacturers as an accepted procedure. Synthesis of sulfa drugs, penicillin, antimalarials, antiseptics, vitamins, etc., is frequently guided by crystal analysis of natural products.

4. Lubricants. Much of the present knowledge of soaps, greases, lubricating oil films, lubricant antioxidant, detergent, film-strengthening additives is based on diffraction studies, especially of molecular orientation in films and at interfaces.

5. Minerals, Clays, Ceramic Materials. Identification, chemical changes on dehydration and calcination, specifications, for example, of manganese dioxide ores for use in dry cells, and even the structure of completely non-crystalline glass from radial distribution curves, are a few well-known uses of X-ray diffraction.

6. Common Inorganic Chemicals. We may extend this usual field of simple heavy chemicals (common salts, acids, alkalies) to other widely used inorganic compounds such as lead

oxides and sulfate, lime and lime hydrates of all varieties, phosphates, carbonates, silicates and combinations in detergents and baking powders, simple fluorescent chemicals, tin, zinc, titanium, calcium, barium, lead compound pigments and fillers, and carbon.

X-ray diffraction is used primarily in this field of inorganic chemicals for the following purposes:

1. To identify any given specimen of a single substance non-destructively as it exists in the solid crystalline form. A pattern is made, almost invariably of the powder type, and then compared line for line with other standard patterns for known pure compounds; or the spacings are calculated and then compared with the ASTM card index of the spacings of several thousand pure compounds, derived from the original Dow-Hanawalt tables. This is quickly done by matching first 2 or 3 most intense lines on the pattern. Such an analysis is then unique, entirely apart from any considerations of exact crystal structure details. It is being used daily in scores of laboratories for this simple purpose.

RECENTLY, it was necessary to identify a minute amount of powder in a fake "cosmic ray concentrator" being sold to gullible people for medical purposes. The pattern was found to correspond with that of $BaCl_2.H_2O$ in the ASTM card index. This compound was then prepared and analyzed, and the pattern of the known compound found identical with the unknown, which was in nowise damaged or changed.

2. To determine the purity of a specimen or analyze a mixture. Each crystalline constituent in a mixture will, of course, produce its own characteristic pattern of lines mingled with lines from the other constituents. Usually about 0.5 to 1.0% of a constituent, say as an impurity, will be required for detection. This can be made the basis of quantitive analysis of a mixture from an evaluation of relative intensities of lines, especially by a method just published from the authors' laboratory (Gross and Martin, Ind. Eng. Chem., Analytical Edition, 16, 95, Feb., 1944). If a solid solution has been formed, lines for the constituent which is the solute will be completely absent, while the diffraction interferences of the solvent constituent may be shifted in position by an amount which is proportional to the amount of the solute constituent.

TWO examples from a large number of these analyses of mixtures frequently resorted to in industrial laboratories will illustrate the significance. A combination of three very common commercial salts, sodium chloride, nitrite and nitrate, is used for meat curing by the packing industry. A very complete X-ray diffraction study, aided also by observation in the polarizing microscope, led to the development of a manufacturing process for these salts codeposited from solution on a heated drum. (Clark and Hall, Ind. Eng. Chem., 33, 98, (1941). This blend had altogether different properties than a ground up mixture of the three salts, in showing very slight solid solution, especially of nitrite in chloride, and crystals which had a head of nitrite and nitrate surrounded by chloride. The growth of cube faces of chloride on the thrombohedral faces of nitrate under a condition of high strain was demonstrated.

Diffraction analysis has been remarkably valuable in the analysis of boiler scale. A current advertisement for X-ray diffraction apparatus reproduces patterns made in identifying scale which resulted in failure of tubes in a Dow Chemical Company boiler. The results are shown in Fig.   which is reproduced through the courtesy of this company. Through this identification, the cause of the hard scale was found in the feed water system and the trouble was rectified. Such patterns have been of indispensable aid in the whole program of boiler water treatment of the Allis-Chalmers Company. A very extensive paper on the subject has been published recently by Imhoff and Burghardt of this company (Ind. Eng. Chem., 35, 873, 1943).

3. To indicate chemical reactions. This very important application may be illustrated by results on various lime problems as obtained in the writer's laboratory under National Lime Association fellowships. Here, there may be absorbed water has been involved in a considerable number of industrial chemicals. The stability of various salts and hydrates as a function of temperature, hydrolysis in solution and other factors is required information in many cases, and is easily shown by the pattern. The unique reaction between basic acid, sorbicylic acid and zinc sulfate to yield a powerful antiseptic and burn treatment could be demonstrated only by the X-ray pattern as completely different from that of any constituent.

4. To measure and control particle size. As indicated previously, the X-ray diffraction pattern may be used to evaluate primary particle size in a specimen, entirely apart

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Editorial and News

Moving Forward in National Association Service

IF WE MAY judge by the accomplishments of the Cleveland Meeting of September 15-16, seven league boots may now be in order for the National Science Teachers Association. Organization plans were completed, a regional association was accepted into its membership, applications for affiliation by state and regional groups were considered, a program of action set up, and a definite service project was started well on its way. It is difficult to see how so much could be accomplished in so short a time.

It should be pointed out that the gathering momentum of the National Science Teachers Association is not a matter of accident, but rather is the result of its position among associations, its excellent organization, and the good leadership of its officers and directors. It is closely connected with the National Education Association and the American Association for the Advancement of Science, both enjoying places of unquestioned leadership in the field of education. Its relation to these two associations places it in a position of natural leadership among other science teacher organizations.

FURTHER its plan of organization is an additional asset, allowing flexibility in relationship with other organizations, permitting affiliation with it, and setting up a plan of co-operative action with affiliated groups through the use of director and consultant representation. Under the constitution as re-drafted by Dr. Reuben T. Shaw of the North East High School of Philadelphia and adopted by the board of directors, affiliated groups not only completely retain their identity and initiative but to the extent they cooperate with the Naional Science Teachers Association may also profit both in membership growth and in service performed. For example, the Garden Club represented by Mr. Paul R. Young of the Cleveland Public Schools was accepted in the National Science Teachers Association and given the privilege of adding to its section all national members interested in this area. It also may have its own sectional program, if desired, at the time of the biennial meetings of the association.

Through affiliation, state and regional groups may also profit. They gain through the opportunity for greater service that can be rendered by cooperative action. Greater service in turn will increase association membership, because it is a known fact that the extent of teacher interest in an organization is determined by the extent that useful functions are performed.

THE LEADERSHIP of the National Science Teachers Association has already initiated the study of a problem that is very vital—a study of "Science in Consumer Education"—and affiliated groups if they desire, may share in the work and also in the credit for its accomplishment. Mr. Nathan A. Neal of the Cleveland Public Schools, who was very active as chairman of the philosophy committee of the National Science Commission, has been chosen to direct the work. Those desiring to work on this problem, or to put their association to work on it, should write to Mr. Neal, Room 624, Board of Education Building, Cleveland, Ohio. Mr. Neal will contact all consultants and directors of affiliated groups of the National Science Teachers Association and offer an opportunity to help.

The problem of "Science in Consumer Education" is a part of a national study of consumer education which is sponsored by the National Association of Secondary School Principals and it has the financial support of the Better Business Bureau. The findings of the committee, headed by Mr. Neal, which will explore what has been done and then establish what is yet to be done and how, will be published in booklet form and distributed free to the membership of the association.

Final Convention of American Council

NATHAN A. NEAL
Secretary
Cleveland Public Schools — Cleveland, Ohio

OFFICERS of the American Council of Science Teachers, already in the process of merging the Council with its sister organization, the American Science Teachers Association, took advantage of the opportunity to hold a one day series of educational meetings during the July 1944 convention of the National Education Association in Pittsburgh. Two major achievements were realized in this final activity of the Council: (1) a number of excellent and timely papers were read and discussed, and (2) the merger with the American Science Teachers Association was culminated during the business sessions of the Council. This article will attempt to indicate some of the high points of the educational discussions and some details of the items of business which were handled at the meeting.

During the morning session, Dr. E. R. Martel, head of the Forestry Department of Purdue University, gave an excellent discussion of "Our Native Land and Its Natural Resources." After tracing the history of use and conservation of natural resources of the nation and giving background material for present day popular and widespread understandings and attitudes in the field of conservation of natural resources, Dr. Martel made a strong case for conservation education in the schools.

Mr. Emil Massey, Director of Science in the Detroit Public Schools, spoke on the very pertinent problem of "Rebuilding with Science." Mr. Massey pointed out some of the pre-war, wartime, and probable post-war impacts of science on the lives of individuals. An understanding of how science is interwoven with activities of everyday living leads to the point of view that science courses in the schools must be alive, vital, and functional during the post-war years.

Miss Bertha E. Slye, of the School Service Department of Westinghouse Electric and Manufacturing Company, spoke on "Science Developments that all Science Teachers Should Understand." Miss Slye pointed out that the complexities of modern living are constantly changing because of our increased knowledge of science and predicted that science will *always* add new phases of problems to be studied. While such problems must be treated as they occur in local situations, there are some general developments that all science teachers should understand. These include something of latest industrial laboratory methods, application of pure science to the almost innumerable details and problems of everyday living through classroom procedures, better use of known techniques with films, charts, models, recordings, exhibits, and the variety of audio-visual aids available from industrial organizations and other sources.

Capt. Daniel C. McNaughton, from the War Department, spoke on "Army Needs as They Relate to Science." Capt. McNaughton pointed out that all Pre-Induction Training, including that which is carried on through science teaching, should be practical, should meet Army needs, and should be thorough.

During the afternoon session members of the Council were guests of Director John F. Landis and the staff of the Buhl Planetarium. Members of the Planetarium Staff discussed aspects of their wartime activities. Council members enjoyed a special demonstration of the stimulating form of science education which is possible only through the facilities of Planetarium projection equipment.

Norman R. D. Jones, president of the American Council of Science Teachers, presided over the business sessions. During the morning session he turned the meeting over to Dr. Philip G. Johnson, chairman of the combined committee to form a merger of the American Council of Science Teachers and the American Science Teachers Association. Dr. Johnson spoke of the history of these two national science teacher organizations and spoke of the need for strength through united efforts.

Mr. H. A. Allen, business manager of the National Education Association, addressed the group pointing out the desirability of forming a strong national group which would represent the interests of all science teachers. Mr. Allen spoke as an official representative of the National Education Association and brought a message of official approval of the new National Science Teachers Association.

President Jones reported that the board of directors and members of the American Council of Science Teachers had voted unanimously in favor of the proposed merger. A

communication from Dr. Morris Meister, president of the American Science Teachers Association, indicated that the officers and members of that group had also voted approval of the merger.

Dr. W. H. Michener, representing the American Physics Teachers Association; Mr. H. W. Baker, a member of the Division of Chemical Education of the American Chemical Society; Mr. Emil Massey, president of the Central Association of Science and Mathematics Teachers; Mr. George Jeffers, of the National Association of Biology Teachers; Dr. Dwight E. Sollberger, of the American Nature Society; and Dr. Reuben T. Shaw, representing the Science Teachers Association of the Middle States, the Pennsylvania Academy of Science and the Greater Philadelphia Science Teachers Association, all addressed the group expressing interest in the proposed merger and in cooperation to the extent possible in terms of the activities and commitments of the various organizations indicated. Communications were read from Dr. Paul F. Brandwein, representing science teacher organizations of Greater New York City; Professor Hugh C. Muldoon of the Duquesne University Conference of Science Teachers in Catholic High Schools; and Mr. Paul Young, president of the School Garden Association of America, indicating interest in the merger and a desire to cooperate on the part of the groups indicated. The meeting was turned back to President Jones and after an appropriate discussion, it was moved, seconded, and carried that the National Science Teachers Association, fully merging the programs and memberships of the American Council of Science Teachers and the American Science Teachers Association, be declared in existence as of July 4, 1944.

During the afternoon business session committe reports were filed with the secretary in order to conserve the limited time available for educational discussions and for an introduction to the facilities and program of the Buhl Planetarium. The newly organized National Science Teachers Association went on record as favoring and recommending the adoption of the metric system as official for use in the United States after the War. A committee was appointed and instructed to draw up an appropriate resolution stating the point of view of the association on adoption of the metric system.

National Science Teachers Association

Minutes of Executive Committee meeting at Cleveland, Ohio, September 15-16-17, 1944.

Members present: Reuben T. Shaw, Norman R. D. Jones, M. A. Russell, Phil G. Johnson, John C. Chiddix, Paul R. Young, Nathan A. Neal.

1 A majority of the time spent in five sessions of the group was given over to revision and rewriting the Governing Rules of the National Science Teachers Association including: Constitution, By-laws, Rules, and Enabling Clauses. The group present approved a draft of these materials to be published in the 1944 Yearbook of the National Science Teachers Association.

2. Membership materials and plans were discussed and forms were approved for printing.

3. The group met with Fred T. Wilhelm, Associate Director of the Consumer Education Study which is being conducted by the National Association of Secondary School Principals of the National Education Association. A plan was approved whereby the National Science Teachers Association will participate in this Study. A committee was appointed to plan and prepare a report on consumer education in science teaching. This committee consisted of George W. Jeffers (invited), Morris Meister (invited), Phil G. Johnson, and Nathan A. Neal, chairman. This cooperative plan was approved with the understanding that adequate financial support will be forthcoming from funds allocated to the Consumer Education Study.

4. There was discussion of a proposed symposium on The Place of Science in Education for the 1945 meetings of the National Science Teachers Association.

5. A committee on professional and public relations was established. Reuben T. Shaw was appointed chairman of this committee.

6. A committee on health education was established. Partial membership of this committee is to include Paul Kambly, chairman (invited), Reuben T. Shaw, and Will R. Burnett (invited).

7. It was moved by Norman R. D. Jones and seconded by Reuben T. Shaw that the school garden department of the National Education Association be approved as a section of the National Science Teachers Association under the following conditions: (a) that gardening as a phase of science operate as a section in the National Science Teachers Association with representation on the Board of Directors on the same basis a is available to other groups; (b) that space in the official journal of the National Science Teachers Association be available to this group on a proportional basis as compared with other groups; and (c) that membership, finances and other activities of the Garden Education Department of the National Education Association be carried forward in the National Science Teachers Association. This motion was carried unanimously.

8. It was moved by Norman R. D. Jones and seconded by Reuben T. Shaw that Paul R. Young serve as the first representative of theGarden section on the Board of Directors. This motion carried unanimously.

9. Nathan A. Neal reported an informal conver-

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The Metric System

HAROLD WM. BAKER

James Ford Rhodes High School — Cleveland, Ohio

Streamlined Arithmetic

THE SCIENCE teacher struggled patiently with his class. They just couldn't do simple arithmetic. He devised a test over the different types of mathematical skills needed in chemistry or physics, and administered it. Results?

A precious few knew algebra. Ratio and proportion were a mystery, to say nothing of fractions and their interpretations. The four simple processes were confusing enough to most of these twelfth graders and they could do a little with decimals. But on problems on dollars and cents, they were nearly perfect!

Other tests were made, with the same startling outcome! No matter what else, the pupils could do money problems. Fractions, volumes, ratios,—these were of another world as far as the pupils were concerned.

At home the science teacher was planning some repairs. Concrete work. Installing windows. Electric wiring. Insulation. Figuring furnace heat capacity to see if he could include those extra rooms. The various ways of figuring made him dizzy too.

Over a century and a half ago the French figured out a remedy so modern that all the rest of the world is using it—THE METRIC SYSTEM.

EVERYTHING in decimals. No more fractions. No more guessing which kind of pounds, or tons, or 56 kinds of bushels, is meant. Everything is on one standard, simple and self-related system—multiples and decimals of units. Units of convenient size, related by multiples of tens, hundreds, thousands, or their decimals. Discard the multifarious units of measurement based on so many different ideas! Banish the various kinds of pounds, quarts, tons, bushels, miles! Yes, throw away the drams and scruples!

Look at the varieties of measurements tabled in any good reference handbook, and laugh at them! Let's join the rest of the world, and use the metric system.

The record: A dozen European countries, and even new China adopted the metric system about 1920. In 1893 our own Congress adopted metric for international trade, and the next year made metric standard for all electrical measurements. Even England must use metric for products for international trade, and the British Dominions have gone on record strongly in favor of the metric system.

OUR DECIMAL system of money is of worldwide advantage, because it is easily learned. The whole metric system can be learned in an hour by a person of average intelligence. Educators estimate that at least a year's time could be saved in a child's education in arithmetic.

Even the conservative American Medical Association is now using metric measurements only. The U. S. Army uses the metric system to a large degree. Many industries have already converted to metric standards. Baldwin Locomotive is one. One railroad estimates that metric units would save at least $50,000 a year in paper work. Some industries have reported that peacetime change to metric paid its cost well within the first year.

To thinking persons, such as science people are supposed to be, there can be no doubt of the time-saving and simplicity. Most of us use and favor the metric system.

Our boys—yes, and girls—will come back from foreign soil well accustomed to metric units. Our factories in many cases use nothing else, and the workers must know metric. The U. S. Coast Guard and Geodetic Survey used the metric system in basic triangulation of the country.

IN INTERNATIONAL trade, we have been handicapped by our variety of ways of measurements—Heaven forbid calling it a system! We are part of the world parade, and our country doesn't need to play 'Tail-end Charlie.'

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Spider Silk

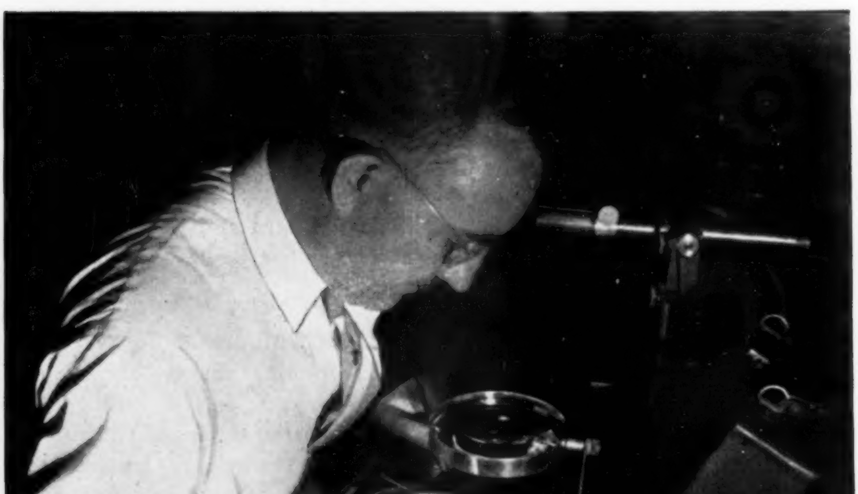
JOHN G. ALBRIGHT, Ph. D.
Professor of Physics, Rhode Island State College Kingston, Rhode Island

MORE THAN two centuries ago attempts were made by the French to utilize spider silk in the textile industry. By patient industry a pioneer, Monsieur Bon of Languedoc, France, collected a large number of spider cocoons and from the very fine gray silk he made some stockings and gloves which were exhibited before the Academy of Science of Paris in 1710. That body showered M. Bon with honors and grew excited over his idea of starting a spider silk factory. Rene Reaumur, the physicist and entomologist, was commissioned to investigate the possibility of growing spiders for their silk.

Although Reaumur began his investigation with enthusiasm he found so many insurmountable difficulties that he was compelled to return an adverse report. The spiders were difficult to manage, they were belligerent, easily excited and cannibalistic. It was found difficult to provide them with proper food and to keep them in large groups as they would fight and devour one another. Furthermore, the silk produced was small in quantity and so fine in quality as to be difficult to utilize in spinning.

ALL SPIDERS spin silk, but members of the subfamily, Nephilinae, spin so much that they have been used often in attempts to establish a spider industry. In 1864, Dr. Wilder, an American Army surgeon stationed in South Carolina, revived the idea of using spider silk in textiles. He selected the brush-legged *nephilia clavipes* and proposed the *milking* method of reeling the fiber directly form the spider instead of collecting the cocoons. He found that the life product of about 450 spiders would be required to produce one yard of the silk. The cost of a spider silk hose would be more than $100 and they would be so sheer that they would be of little service.

More recently another species, *nephila Madagascarienais*, found in Madiscar, has been used in making silk cloth. The female alone produces the silk and is about 2½ ins. long. The silk is reeled from the spider by native girls five or six times in the course of a month, after which the spider dies, having yielded about 4000 yds. of fiber. About one dozen spiders are locked in a frame in such a manner that on one side protrudes the abdomen, while on the other side the head, thorax, and legs are free. The ends of their web are drawn out, collected into one thread which is passed over a metal hook and the



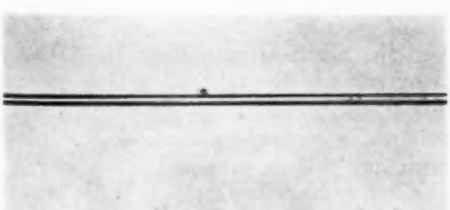
Dr. Albright at work mounting spider silk cross hairs

Taking silk from the spider

reel set in motion by a pedal. The extraction of the silk does not apparently inconvenience the spider. The cost of the material is high as about 55000 yds. of 19 strands thickness weighs only 386 grains and one pound of the silk is worth $40. At the Paris Exposition of 1900, a fabric was shown, 18 yds. long by 18 ins. wide, containing 100,000 yds. of spun thread of 24 strands, the product of 25,000 spiders. It wasgolden yellow in color.

ALTHOUGH Spider silk has proved impractical for textile use, it has found a field of usefulness in the optical industry as cross lines in various instruments. The intersection of two taut fibers of spider silk is used to mark the optical center of telescopes and other optical instruments used in astronomy and surveying.

Spider silk fiber enlarged 500 times.



In 1763 two Englishmen, Charles Mason and Jeremiah Dixon came to America to survey the famous *Mason and Dixon Line* between Maryland and Pennsylvania. They brought with them the finest surveying instruments available in England and, on arriving in Philadelphia, they were surprised to find that an American astronomer, clock builder and instrument maker of that city

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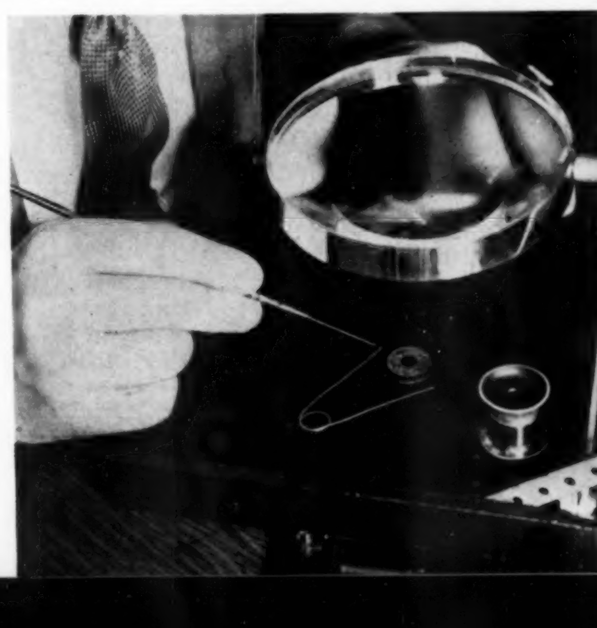
Holding spider silk fiber in position on the ring while mounting.



The Physiological Disturbances of Flying*

BY CHALMERS L. GEMMILL

Commander (MC) U. S. N. R., School of Aviation Medicine, Naval Air Training Center, Pensacola, Florida

ALL NEW forms of transportation develop new medical problems. However, it was not until the invention of the airplane that man was stressed to the limit of his capacity and it became necessary to perfect devices capable of protecting him against these forces. Therefore, aviation medicine involves a combination of medical and engineering knowledge. A table (Table 1) is given of some of the physiological stresses on man. The doctor studies these physiological changes taking place in the man in the plane. The engineer, using this data, devises and builds protective equipment around the man in order that the aviator will avoid these stresses. The doctor then restudies the man with the protective device in order to see if the man is kept physiologically normal and to obtain the limits of the protection.

TABLE I.

PHYSICAL CHANGE

Lowered Barometric Pressure
Lowered Barometric Pressure
Lowered Temperature
Acceleration

PHYSIOLOGICAL EFFECT

Anoxia
Aeroembolism
Feeling of
Intense Cold
"Black Out"

ENGINEERING PROTECTION

Oxygen Equipment
Pressure Cabins
Pressure Suits
Heated Cabins
Heated Suits
Suits
Suits

*The opinions and assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department.

Taken from a speech given by Lt. Col. Jay Dykhouse, Chief, Pre-Induction Training Branch, Military Training Division, Hq, Eighth Service Command, Dallas 2, Texas, to the American Council of Science Teachers.

Lowered Barometric Pressure:

AS MAN ascends in a plane, he becomes exposed to lower barometric pressure. This fall in pressure causes the pressure of the oxygen in the surrounding air to fall and, as a result, the pressure of oxygen in his alveolar air decreases. The driving force to get oxygen across into his blood diminishes. In turn the amount of oxygen carried by his blood becomes less than normal. The actual amount of oxygen in his blood depends, therefore, on the external barometric pressure. At 18,000 feet, where the barometric pressure has been reduced to one-half the sea level value, man shows marked physical and mental changes. His pulse rate increases, his peripheral vision decreases, and less attention is paid to his surroundings. He is mentally dull and may do irrational deeds. In fact, the aviator becomes a very inefficient individual, both mentally and physically. However, if this man gets 100 per cent oxygen, he again becomes a normal man and is able to carry out his duties. In fact, at altitudes less than 34,000 feet, he does not need 100 per cent oxygen and may be restored to normal by mixtures of air and oxygen. Therefore, it is the duty of the engineer to design adequate oxygen equipment to aid the aviator.

Oxygen Equipment:

ALL OXYGEN equipment may be divided into the following types: (1) Constant flow, (2) Demand Type and (3) Rebreather Type. In the constant flow type, the oxygen flows in a steady stream to the user. It is obvious that this type is very wasteful of oxygen. In order to avoid this waste, the demand type was developed. In this apparatus, there is a valve which opens when the man breathes in and closes when he breathes out. Therefore, he only obtains oxygen when he demands it on inspiration. A dilutor valve may be placed in this apparatus in order to give mixtures of oxygen and air up to 34,000 feet. Above this altitude man must have 100 per cent oxygen. In the rebreather type of equipment, the expired air is passed through a cannister in order to remove the carbon dioxide and then is breathed into a bag from which it may be rebreathed. It is obvious that this type is very economical of oxygen but

is also very complicated since it must use a cannister, numerous valves and other complicated devices. The best type at the present time is the dilutor-demand type of oxygen equipment.

Aeroembolism:

The second problem which arises when men are subjected to a reduction in barometric pressure is aeroembolism or the "bends." This condition is caused by the release of pressure on the dissolved gases in the body. As the external pressure becomes less the gases are liberated in greater quantities. If the circulation and respiration are inadequate to carry the gases in physical solution, bubbles will form either in the tissues or in the blood stream. The severity of the symptoms produced by these changes are due to the anatomical location of their formation, and to the amount of gas liberated. The latter factor depends on the height to which the man ascends, the rate of ascent and the time at which he remains at the high altitude. Symptoms generally do not occur until man reaches 30,000 feet.

THE SIGNS and symptoms of aeroembolism are many. Some individuals get slight pain in a joint, later this pain becomes so severe that the man is forced to descend. In others, the pain may disappear. Temperature sensations may be present in the skin. Choking sensations may develop. In fact, many and varied clinical changes may be observed in this disease. The cure is a quick descent. The increase in barometric pressure decreases the size of the bubbles and drives them back into the tissues. Generally, when man descends to 15,000 feet after having had the "bends" at 30,000 feet all symptoms disappear. Exercise at altitude increases the incidence of this condition. Aeroembolism may be abolished or the severity of the symptoms diminished by the breathing of pure oxygen prior to flight.

Engineering protection may be provided against this condition by the construction of pressure cabins or pressure suits. In these cabins or suits the man is never exposed to the extreme changes in barometric pressure at which the plane may fly. Pressure cabin planes have been developed for commercial travel. For military purposes, additional problems arise in the development of such cabins and suits. These problems can be solved and the engineer will, therefore, give protection to the man against both anoxia and aeroembolism.

Temperature:

As man ascends, he is exposed to colder conditions than is generally found on the surface of the earth. In fact the temperature at 35,000 feet is in the region of –55° C. Man has no mechanisms capable to withstanding this extreme cold. He, again, is dependent on the engineer to supply heat to the cabin or to give adequate clothing. The latter may be either heated or non-heated. The heated suits have the advantage of being very light in weight but dependent on electrical power from the plane. In case of power failure or forced descent in a cold climate, the man has no protection from this type of suit. The non-heated suit is bulky but does not depend on power from the plane. Therefore, it would give protection at all times. It is the ideal tyep to be worn under Artic conditions since it would protect a man forced down in the extreme cold.

Acceleration:

ANOTHER stress placed on man during flying is that of acceleration or change in velocity. Standing on earth, man is pulled down with his own weight which is equivalent to the force of gravity or "G." If man is placed in a centrifuge or in a plane in which the machine has a rapid change in velocity (acceleration) many more "G's" may be developed. In fact, in a pull out from a dive 6 or 7 times the force of gravity may be exerted on the man and plane. When these forces are exerted from head to foot in man, the blood is forced into his legs and abdomen. The pooling of blood decreases venous return to the heart, which, in turn, causes the cardiac output to become less. The latter factor lowers the blood pressure which causes the flow of blood through the brain and eyes to decrease. Therefore, the prominent symptoms are the feeling of heaviness in the legs and arms due to the pull of gravity and the "gray out" and "black out" due to anoxia of the eyes and brain resulting from the decrease in flow of blood to these regions.

The engineering protection in these cases is to supply suits to prevent the stagnation of blood in the legs and lower abdomen. This has been done with a noticeable increase in "g" tolerance.

Summary:

From this short review of a few of the medical problems of flying, it is of utmost im-

portance that the doctor and the engineer work together for their solution. In the past the engineer has built the plane with little regard for the man. The performance of the plane exceeded that of the man. Therefore, it became necessary to design protective devices for the man in order that he can keep up with that of the plane.

IN GENERAL, the schools of the country have done a splendid job in furnishing the Army with high grade men and women. Practically all the personnel in the Army are products of our school system. Some critics are inclined to look only at the small per cent who fail, rather than at the great number who are making a real contribution to the war effort. The fighting of a mechanized, technical, and scientific war requires personnel of a highly trained type.

We should all realize that students in our schools are individuals, and, as such, possess a great variety of and range in, skills and abilities. In other words, some have a cup capacity while others are of the barrel capacity. To expect all high school graduates to be of equal ability is unreasonable since they come from every strata of society and are not all of inherent equal ability under normal conditions. They all should, however, have the right and privilege to remain in school and develop up to the limit of their ability at their own rate of speed and to be given material according to their ability and needs.

THE ARMY has no intention, or desire, of telling educators what to teach, what textbooks to use, how to teach, or to interfere in any way with the administration of our school system. The Army has, however, discovered by careful research and in the field what its needs are relative to fundamental skills. The Armed Forces have also encountered definite shortages in some trades and skills. They feel that the attention of educators should be called to these matters and that the educators in turn will help meet the expressed need.

You have all been exposed to a lot of information, misinformation, sense, and nonsense from many sources as far as the needs of the Army are concerned, and what can be done to help the situation. You all realize that you should do your part in preparing the prospective soldier physically, mentally and spiritually for the duties and trials that lie ahead. You are becoming aware that proper guidance, in and out of school, has become, practically speaking, a necessity. When it comes, however, to the actual working out of the problem, every educator has his own opinion. For example, one educator, after returning from a conference, stated that from now on only physical education and shopwork would be taught. Another stated that the "Lady of the Lake" should be placed in the bottom of the lake until the end of the war. One educator went so far as to say that the whole curriculum should be scrapped and a new one substituted. It might be well to caution that in changing the entire curriculum one should be careful not to "throw the baby out with the bath water."

Generally speaking, it should not be necessary or desirable to revise the whole curriculum. A pointing up of all subjects with a war slant and emphasis, and the insertion of some new material or units should adequately meet the situation. The changes made should, of course, be fundamentally sound and, in most instances, would be valid before, during, and after the war.

THE REPORT of the War Department is to the effect that personnel shortages exist in certain definite fields such as radio, electricity, mechanics, and related fields of communication. These shortages, in turn, immediately resolve themselves, to a great extent, into a need for more fundamental knowledge of mathematics and physics.

To meet these needs requires careful guidance and good judgment on the part of educators. To conclude immediately that to meet this situation all students should have four years of mathematics would probably not be desirable. One educator put it in the following manner: "They would have four years of mathematics, all right, but it would be the first year four times." Likewise, if all were to take the course in physics as usually presented, the casualty list would be around fifty per cent.

A MISCONCEPTION which exists quite generally is that a high per cent of the soldiers need a working knowledge of advanced algebra, solid geometry, and trigonometry in order to perform their work in a satisfactory manner. If a study were made of advanced training manuals and officers' courses, one might very reasonably reach these conclusions as actually happened in several early reports on Army needs. However valuable, desirable and necessary these subjects may be to a certain per cent of the officers and men, the fact remains that about ninety per cent of the men

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Life of Edward Bausch and Our Youthful Scientists

THE LIFE of the late Edward Bausch, chairman of the Bausch and Lomb Optical Company, marked by a keen interest in science and filled with distinctive achievements, is one that should be a stimulus to boys and girls in the science field.

Evidently as a boy he had more than a passing interest in science in the schools. In addition to being inquisitive as to physical and biological phenomena he had a full share of that urge of every boy and girl to want to do something and to apply science in some useful way. He came by his experimental inclination honestly, as his father had set the example before him and was the one who adapted vulcanized rubber for use in frames in spectacles. The fact that Edward helped his father with experiments may account for his own active purusit of science hobby interests.

However, Edward's chief interest was in lenses, as might be expected. At the age of fourteen when most boys and girls enter high school he had already developed great skill with tools and showed aptitude for optical design. By the time he entered college he had designed and built a microscope.

Dr. Edward Bausch, chairman of the board of Bausch & Lomb Optical Company of Rochester, N. Y., who died at his home July 30, 1944.

HIGH school students may well note that Dr. Bausch's science interests as a youth of high school age and his project activities helped him greatly in the work he was to follow in life.

He has to his credit a number of inventions, including microtomes, invertible microscopes, binocular microscopes, and centrifugal testing machines. His famous iris diaphragm shutter made the snapshot camera a popular plaything.

In close cooperation with the instrument division of the United States Coast Survey he helped to work out telescopic gun sights to make the guns of the Navy more scientific. During World War I optical glass was developed by Dr. Bausch's organization and met the critical needs of the Armed Forces. Again in World War II his organization has done revolutionary work in providing superior lenses for instruments to help defeat the enemy. The story of these achievements must wait the close of the war to be told.

The late Dr. Edward Bausch is an outstanding example of a man whose life has been lived in an atmosphere of scientific investigation and achievement, both as a youth and as a man. His life should be an inspiration to youth for all time.

Science for Society

EDITED BY JOSEPH SINGERMAN

• **A department in which science is presented in its close relationship to the individual and in which guidance is given in causing the individual to recognize the methods of science and its vast social implications.**

For Defeat of Fascism

IT IS time for people of science to take inventory. Reports of the alleged arrest of Alexis Carrell coincide with substantiated reports of the Nazi extermination center at Lublin. Nobelist Dr. Carrell was led by conviction to join the pro-Fascist rulers in France. He assumed directorship of the Foundation for the Study of Human Problems.

At Lublin, Poland, the Fascists utilized their much vaunted technological technique in solving their human problems. Their plant was scientifically built and efficiently arranged to handle a case load of some 1,400 per day. Survivors of harrowing transportation ordeals from remote parts of Europe, driven on with promise of work and food, undressed and partook of hot baths. It must have been a refreshing experience, after weeks or months of unmentionable filth. It was quite scientific. The hot bath conditioned the skin to more effectively absorb the poison gas prepared for this special purpose. Nothing was wasted. The various personal effects were neatly sorted, stored, inventoried and requisitioned for use in the homeland of the superior race. Bone ash, gathered after the cremation process, was requisitioned for garden fertilizer. No doubt, the flowers bloomed beautifully.

IF THERE are scientists, and, no less, science teachers, who dream of ivory towers, they are deluding themselves. Dr. Carrell made his choice. There were a few others. Every scientist, every science teacher, plays a part in the everyday relations of human endeavor. You take sides even if you choose to ignore the social impacts of science no less than the soldier who ignores the movements of the enemy about him, only in a different way.

The Nazi army, at the present writing, is approaching complete defeat, and may even lay down its arms in the very near future, maybe before this printers ink is dry. But, the machinery of international cartels, though badly strained, is in condition for resumption of the kind of activity which helped nullify the Treaty of Versailles, that bolstered the technological and military might of our enemies while hindering our own scientific and technological development. The germ of Fascism is nurtured too by doctrines of racism, another contradiction to American democracy.

SCIENCE and invention make possible a broader and more satisfying life. But their benefits have been partially or wholly denied thru the operation of cartels. Sick people are denied medicine, unfortunate people lack adequate food. International cartels have functioned, in the period intervening between the two world wars, to strengthen our enemies, meanwhile retarding our development along strategic lines. The power of cartels reached above and beyond government.

While, thru the action of cartels, our enemies strengthened their weapons, by fostering and nurturing false doctrines of racism they gnawed away at the moral fibre of those they planned to conquer. The science teacher is of course interested in expounding the observed facts of race and seeks to dispel unfounded prejudices. But his horizon is limited if he does not delve more deeply, into the soil of economic fear in which these superstitions find support. The misguided as well as the demagogue will find willing ears in the postwar situation. The virtual defeat in Congress, for the present at least, of the Kilgore-Murray Bill, providing for a basic standard of economic security for all American people, is viewed as a catastrophe by the scientist with a social conscience just as much as the present trend in the Senate which seems destined to doom the proposed establishment of a permanent Fair Employment Practices Committee.

THE ARMIES of democracy are victorious over their armed foes; but the war against Fascism is entering its more difficult phase. The cancer of racism and the economic condi-

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Health Education Checklist

A Report of the Health Education Committee

HEALTH EDUCATION, if it is to be a justifiable part of school programs, must be made up of materials and practices so basically and realistically planned that there can be no doubt about their influencing constructively the behavior of the pupils for a long time after the course is over.

It is suggested that health education committees, teachers of health, and school systems may estimate the value of their educational service in relation to pupil health by checking their practices through the answering of questions which have been selected to give emphasis to some of the features of functional health teaching.

THE QUESTIONS which follow have been prepared by some of the persons who were members of a committee that cooperated with the Pre-Induction Training Branch of the War Department in the study of health education for potential inductees. While space limitations cause the list to be incomplete and often general yet it is recommended for use in schools throughout the nation.

1. Are you using Medical Handbooks of Service Units as references in your health course?
2. Are you arranging your instruction so that your pupils check themselves against physical tests similar to those used for Service units and for civilian occupations?
3. Are you arranging your instruction so that your pupils check themselves against mental tests similar to those used for Service units and for civilian occupations?
4. Are you arranging experimental laboratory work which vividly reveals miscroscopic organisms and the conditions favorable for their development?
5. Are you including in your instructional materials the use of sound films showing the activities related to induction?
6. Do your plans include the use of men and women home on furlough to talk about their experiences with students nearing the induction age?
7. Are you encouraging students to hear and discuss letters about experiences from persons in the Service?
8. Do your pupils hear newsreports and read the better service stories as a part of instruction in English and related subjects?
9. Is substantial instruction given on social diseases; their nature, effects, and prevention, given to all students?
10. Are your pupils given careful physical examinations and are they urged to correct remediable deficiencies? Is there a plan for follow-ups to further induce action in making corrections?
11. Are you instructing your pupils in both certain basic First Aid procedures on themselves personally?
12. Are you requiring students to practice the theory and general practice of First Aid?
13. Are you using Red Cross First Aid Manuals and do students have the opportunity to earn First Aid Certificates as a part of school activities?
14. Does your school offer instruction in the maintenance of home medicinal and first aid supplies and equipment?
15. Are you giving pupils opportunities to develop hobbies which can be followed while in Service?
16. Are pupils instructed in many and varied hobbies to the point where they can wisely select and follow some of these activities for relaxation?
17. Are you allowing pupils to compare opportunities in the Service with opportunities in civilian trades and professions?
18. Do your pupils receive guidance so that wartime opportunities may not cause too severe disillusionments when adjustments to post-war conditions are made?
19. Are you instructing your students in the relation between rest and a feeling of well being?
20. Are you giving many and vivid illustrations to show the relation of habits to safety from accidents?
21. Does your school stress cleanliness of

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Science Clubs at Work

Edited by DR. ANNA A. SCHNIEB

State Teachers College Richmond, Kentucky

• A department devoted to the recognition of the splendid work being done by the science club members and their sponsors in the various State Junior Academies of Science. Material for this department, such as student made projects; demonstrations and posters; outstanding club programs; state and regional meeting announcements; should be sent to Dr. Schnieb.

The Science Club makes it possible for the high school science teacher *to recognize* and *to provide* for individual differences in her students and at the same time to contribute to *productivity* rather than to *receptivity* and to *lethargy* on the part of the students. That high school students can carry on with the minimum amount of guidance, a systematic program which leads to genuine thinking and originality is clearly shown by the excellent work of the club members of the Science Club, Central High School, Detroit, Michigan. Mr. Louis Panush, sponsor, is most enthusiastic over the possibilities of club work. The following articles are suggestive and are worthy of careful study.

Please, let us hear from other science clubs. This Department can be a clearing house for the various science clubs. Your cooperation will increase the value of the Department. It is an honor to be represented in *The Science Teacher*.—ANNA A. SCHNIEB, *Editor*.

A Forward Looking Science Club*

TED SACHS, Club Member

Central High School Detroit, Michigan

IT HAS often been said that the future of America lies in her youth. If this be true, then the alertness and resourcefulness of members of Science Clubs in this country are indicative of a brilliant future.

The Science Club of Central High School, Detroit, Michgan, is making it possible for the members to discover and to cultivate their interests in the various fields of science. This club was reorganized in 1937 for the purpose of providing opportunities for the members to utilize their creative abilities in scientific interests, to encourage questioning, and to carry on genuine study outside the classroom concerning problems arising in the class hour. The initiative, planning, and the responsibility for the success of the programs lay entirely with the members.

The officers of the club, well in advance of the second semester when the club activities began, formulated the theme for the work: "Science at War." Programs were planned for intervals of two weeks with members participating in each program and with authoritative guest speakers to develop further the issue and to summarize the discussions.

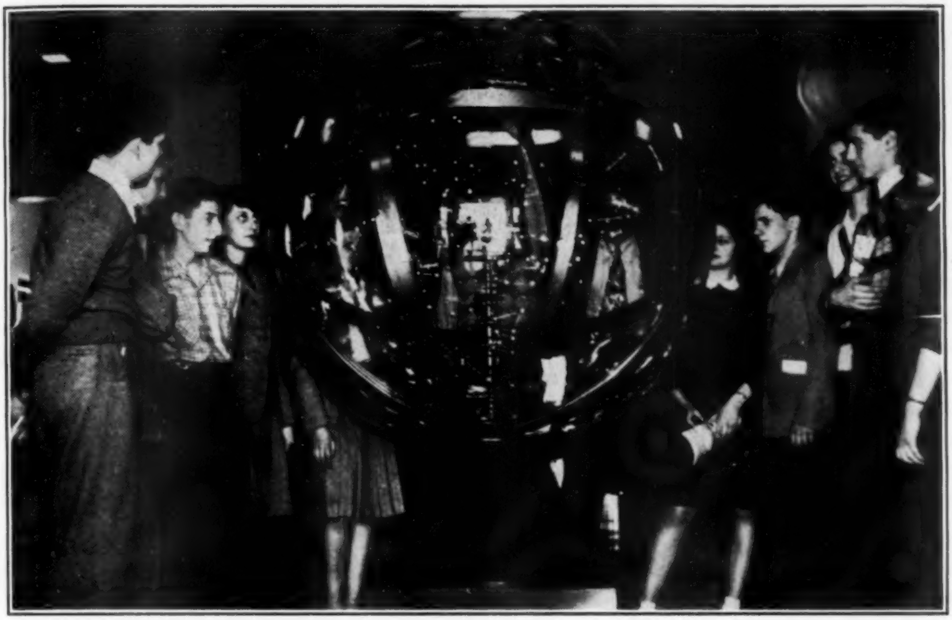
The theme was subdivided into the following headings:

1. Physics at War,—Radar, Electric Warfare, Recording on Wire.
2. Chemistry at War,—Poison Gases, How and Why of Explosives, Synthetic Rubber, Light Metals.
3. Medicine at War,—Sulfa Drugs, Penicillin, Synthetic Quinine.

AT THE beginning of each program, a Science News Reporter devoted fifteen minutes to the summarization of the most important developments in the field of science. These reports were based on *Scientific Monthly*, *Science News Letter*, *Time*, and other scientific periodicals. The members showed much originality in sharing their reports.

To round out the programs for the semester, two leading scientists in Detroit, presented lecture-demonstrations on the use of Gelatinous Capsules in Medicine and on Aviation Fuels. Due to war restrictions on transportation, the usual trips to manufacturing plants could not be taken. However one trip was made to the Cranbrook Institute of Science which is a famous museum located near Detroit.

*Mr. Louis Panush, sponsor of the club here discussed, is also editor of the Metropolitan Detroit Science Review.



The X-Ray Science Club Visits the Museum

THE semester's activities were culminated with the publication of the sixth annual issue of the club's magazine, *The X-Ray*. This periodical was first published in 1938 as a mimeographed pamphlet having a circulation of about 360 copies. Today it is a beautifully printed and well-illustrated magazine with over two-thirds of the student body, more than 2,200 members as subscribers. It makes a point to keep the readers well informed concerning the most important recent developments in science. The last issue featured the theme for the club work, "Science at War" and followed closely the plan of the programs. *The X-Ray* as a student publication having numerous contributions from students who were not members of the Science Club as well as from club members, was enthusiastically received by the student body, by the teachers, and by the administrators.

In addition to conducting the regular club meetings and publishing *The X-Ray*, the science club members presented a program of chemistry and physics experiments to all the biology classes. This was done for the purpose of getting these students to continue their work in science during the eleventh and twelfth grades. These demonstration programs are semi-annual contributions of the Science club to the science department. Several of the club members also participated in the Third Annual Science Talent Search, sponsored by Westinghouse and by Science Service.

ARTICLES FOR PUBLICATION

The Science Teacher is always interested in good material for publication. We especially like the club section articles describing activities of clubs or of club members that can be duplicated by other clubs or club members. Plans used for building membership, creating interest, and raising funds are also desired. If you have ideas you would like to present, write us about them.

NATIONAL ASSOCIATION MINUTES

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sation with F. R. Moulton, Permanent Secretary, and Otis W. Caldwell, General Secretary, of the AAAS on relations between the NSTA and AAAS. Both of these officials expressed personal opinions to the effect that: (a) it is desirable for the National Science Teachers Association to attempt a steady growth through increasing service and usefulnes to science tecahers; (b) it is important that over expansion be guarded against in the early developmental stages of the group; (c) the NSTA may conduct meetings in connection with all meetings of the AAAS; and (d) it would seem highly desirable for the NSTA to make every possible effort to cooperate with and support existing groups with similar and related objectives. Both Dr. Moulton and Dr. Caldwell expressed extreme regret that their duties as executive officers of the AAAS made it impossible for themto participate in the Cleveland discussion of the NSTA executive group.

NATHAN A. NEAL, *Secretary*.

Some Experiments in Meteorology

HYMAN RUCHLIS

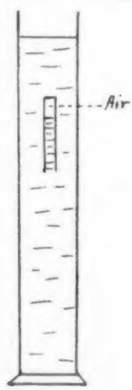
Lafayette High School New York

THE PROBLEM of selecting appropriate demonstrations in meteorology is complicated by the fact that many of the phenomena dealt with involve masses of air hundreds and thousands of miles in extent and are therefore difficult to bring into the confines of the classroom. Yet there is considerable room for application of physical principles on a smaller scale and in sufficiently analagous situations to be of value. Three such experiments are included below as samples.

Conditional Stability

This condition, an important one in the formation of thunderstorms, may be demonstrated with the apparatus used for the Cartesian Diver. A small inverted vial is floated in a tall cylinder of water with an amount of air just sufficient to prevent it from sinking. This condition may be achieved by filling it with air a bubble at a time from a medicine dropper until it floats. It will be found that if the vial is pushed under water a short distance it will return, showing a stable condition. However if it is pushed under several inches the increased density of the trapped air in the vial due to greater pressure will cause it to sink at a definite level, thus manifesting conditional stability. If the vial is raised from below with a hooked wire or deflagrating spoon and released it will return to the bottom unless it is raised beyond the level found in the previous part of the experiment. If raised above this level it will accelerate upwards just as the particle of air in nature does when displaced too far.

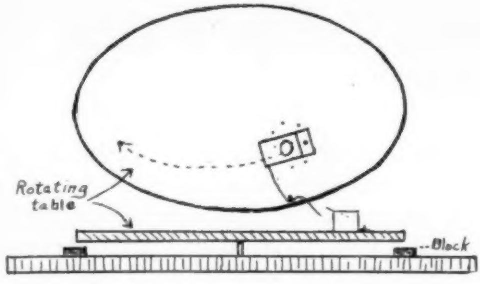
The tube containing air can be made to float or sink.



This provides a physical picture in the classroom of the condition found in nature.

Ferrel's Law

All masses of air in the Northern hemisphere are displaced to the right when in motion and to the left in the Southern hemisphere because of the different rates of rotation of the surface of the earth encountered at various latitudes. This concept is difficult for pupils to visualize because the usual explanation involves highly abstract concepts of linear and rotational velocities far beyond the ability of most high school pupils to comprehend. The typical demonstration used in the classroom is to squirt water from a medicine dropper onto a rotating globe and showing that the path of the water is curved. However this is not quite applicable because the motion of the water is external to the globe whereas the masses on the earth are part of the earth and have the same approximate velocity of the earth. The real situation may be duplicated with a rotating board on which is mounted a device which propels a ball with a given velocity in any desired direction along the plane of the board. The simplest method of propulsion is through the use of gravity with a tripping device which releases the ball while rotating. This propulsion device may be fixed in any desired direction by means of a pivoting nail and a peg which fastens the device into any one of six different directions. The string which releases the ball is fastened to the circumference of the rotating board and is tripped by pulling the string with the finger when the board is rotated. The path of the ball may be shown by using a sheet of carbon paper placed on white paper covering the disc, or by using some talcum powder and wetting the ball.



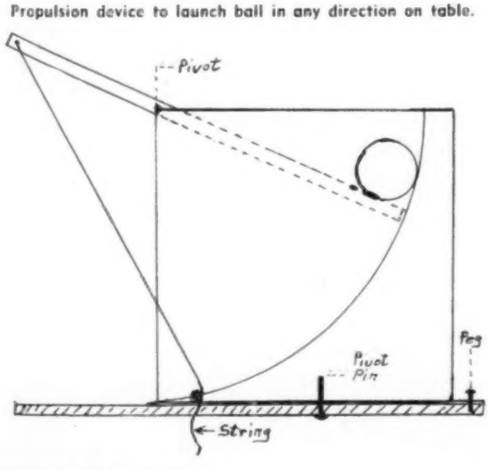
Arrangement of rotatin; table to show deflection to right or left.

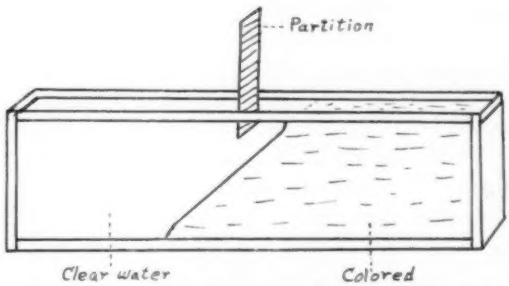
THIS APPARATUS has the advantage of showing clearly the fact that masses moving in *any* direction on a rotating surface will be deflected to the right or left depending solely on the direction of rotation of the board. By reversing the direction of rotation the deflection for the Southern Hemisphere may be demonstrated, the effect of changing the rate of rotation on the deflection may also be shown.

Cold and Warm Fronts

This important concept in meteorology is difficult for pupils to grasp adequately without some picture of what is occurring. This picture and the cause of the phenomena may be neatly illustrated with a special tank one inch wide, three feet long and about eight inches high. The front, of glass, permits a view of the movement of the water masses within. The back is made of a slightly convex plywood. A thin vertical piece of plywood or metal, of the same width as the inside of the bottom of the tank is clamped in a vertical position in the center of the tank thus serving as a partition between two water masses. The tank is filled with water until the level in both partitions is equal and some permanganate solution is added to one side to make it visible and to increase the density of the water on that side slightly. The clamp is loosened and the partition carefully removed. An almost perfect wedge shaped front forms which moves along the bottom, representing a cold front, while the less dense mass moves along the top with the general appearance of a warm front. The rate of motion may be varied by changing the density. An alternative method is to use a difference of temperature between the two masses. However this is a bit more difficult to standardize.

Propulsion device to launch ball in any direction on table.





Heavy colored water is used to show motion of a cold front in air.

It will be found that the two masses of water maintain a very clear surface of discontinuity for a considerable length of time, thus providing a very clear picture of the same phenomenon in nature.

Do you receive the Agricultural Research Bulletins from Swift & Company? These Bulletins are sent free upon request and would be of help to all science teachers but especially to biology teachers. The Spetember issue discusses the damage to lamb pelts and meat by spear-pointed seeds. Some issues present the cartoons known as "Agriculturally Speaking." Address the company in Chicago and ask to be placed on the mailing list.

How to Illustrate a General Law in Physics

ROSCOE J. COATS

Central High School Detroit, Michigan

PHYSICS should be taught around a few principles. Many instances and illustrations of general principle should be found. There should be a continuity of truth throughout the whole course of physics. The high school pupil will have a greater love and a greater respect for the subject if he can see and feel this continuity. Physics should not be looked upon as an encyclopedia of unrelated facts. The law of Conservation of Energy is first illustrated in the general law of machines and in each of the six simple machines. In the inclined plane for instance, the effort times the length of the plane equals the restistance times the height of the plane. The work put in equals the work gotten out. The efficiency which represents that ratio is 100%. The above applies to the ideal machine, a machine in which there is no friction. How about a machine in which there is friction? The law still holds. The extra effort used times the length of the plane represents the wasted energy. The energy however is not lost. It is accounted for. It is used to produce heat, but heat is a form of energy.

Pupils will invariably bring up the subject of perpetual motion machines. I always welcome a discussion on this subject and point out that no matter how clever and ingenious the contrivance may be that perpetual motion is not possible of realization because of the general law of conservation of energy.

NO DOUBT every physics teacher has been approached by this question "Why can't I make a motor that will run a dynamo and a dynamo that will run the motor?" Let the motor run a washing machine for instance. Of course the teacher explains, mentioning friction and the law of conservation of energy.

Another beautiful illustration is in the use of the electrophorous. A certain amount of energy is used in charging the sealing wax disk by friction. The metal plate is brought near, grounded, lifted, and discharged. This can be repeated several times without recharging the wax. The sum total of the energy created by the electric sparks is greater than the energy used to charge the sealing wax. It is to be pointed out to the pupil that not only is work done against gravity in lifting the metal plate but work is also done against the attraction of separating the electric charges. If we consider this extra work done there again is no gain of energy.

Lenz's Law is perhaps the most beautiful of all the illustrations of the Law of Conservation of Energy. When a north pole is thrust into a coil of wire a current is induced in one direction. When the north pole is withdrawn from the coil of wire a current is induced in the opposite direction, as is evidenced by the deflection of the galvanometer needle. Applying the right hand rule for finding the polarity of an electromagnet it can be shown that the north pole is brought in against the repulsion between like poles, north and north, and withdrawn against the attraction between unlike poles, north and south. The important thing to observe is that energy is used in every case; that the energy represented by the induced current is accounted for by the mechanical work done in inserting and withdrawing the magnet.

I AM GOING to give one concise and quantative mathematical illustration. Lift a 10 pound mass a vertical height of 64 ft. The work done is 640 foot pounds The potential energy is now 540 foot pounds. Now allow the 10 pounds mass to fall. Calculate the potential and kinetic energy at the end of any period of time, let us say one second. The velocity is found from the formula:

$v=gt$. Since $g=32$ ft/sec/sec., and
$t=1$ second, therefore, $v=32$ ft/sec.

Now use the formula, Kinetic Energy $=\frac{mV^2}{2g}$.

Substitute in the formula the values, $M=10$ pounds, $v^2=(32 \text{ ft/sec})^2=1024 \text{ ft/sec.}^2$, and $g=32$ ft/sec/sec. Therefore K.E. $=160$ foot pounds.

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Laboratory Tests in the Rock Island Arsenal

MILLARD W. PRATT

United Township High School East Moline, Illinois

THE FIRST written records of the Rock Island Arsenal Laboratory date back to May 10, 1872. These were signed by W. P. Butler, 2nd Lieutenant of Ordnance and had to do with physical tests of stone, iron bars from the roof trusses of Shop E, bessener steel wire, and the density of cements. These old records show that tests were made on stone which was used in the construction of the Washington Monument in 1879. Later records in 1880, showed that the Arsenal was rolling its own iron and that physical tests were made on this. Still later records show that the Laboratory was doing routine mechanical testing on 0.2″ iron for tires for the wheels of gun carriages, compression tests on springs for the 7inch howitzers, "D" rings for artillery harnesses, leather straps and curb chain hooks.

In the"Physical Testing Laboratory" is tested all tensile specimens on a Riehle Testing Machine formerly of Philadelphia, but since 1935 made in East Moline as a division of American Machine and Metals, Inc. They also check the hardness, using one of the four methods: the Scleroscope, the Brinell, the Vickers, or the Rockwell. All springs must be tested, and weighed at several points during compression and expansion. Some are flexed for a given number of times, and retested again. They "prove test" all important components which are made that are to be used in any machine. Every casting must be tested and every alloy must undergo physical tests.

ALL BAR STOCK steels purchased must be "macro-etched" in a 50% HC1 bath for from 15 minutes to an hour to check whether or not they have cracks, seams, and pipes which are easily recognized. Dentritic structure can also be seen. The bath should have a temperature of 160°F or should be held between 155°F and 175°F. When defects have been found on any "tool steels" micro-examination must be made. Here a small section ½ inch square by ⅜ inch high is put in a bakelite mount to facilitate handling. First it must be surface ground; then ground on a special abrasive that is coated on paper from grades No. 1 through 3/0 to take all the scratches away; then washed and held on a rotating wax wheel which has fine levigated alumina on it, and finally on a silk wheel which has finer alumina or jeweler's rouge. It is then carefully washed and dried. The specimen is next put on the microscope. There should be no scratches; and round dark spots are noticed. These are non-metallic inclusions called "oxide' slag. When the specimen is moved several dark lines appear that have a gray cast. These are the "sulfide" slag. These slag inclusions must then be rated by a standard dirt chart. Then the steel must be etched by either the Nital or Picral etch and re-examined to get it's composition, the relative amounts of components, and the identification of its structure. Grain size can also be determined.

Magnaflux inspection of metals is carried on quite extensively at the Arsenal Laboratory, and many surface defects or faults can be determined by this method.

THE ARSENAL has a very large, 400,000 volt, possibly the largest X-ray Laboratory in industrial use. Its purpose is mainly two-fold; first, to insure soundness in highly stressed areas, and second, to make certain that machining operations will not open up defects which will later cause scrapping of a part. It has been the experience at the Arsenal that most contractors submit one or more samples before going into production on a very large order. These are given a very thorough X-ray inspection which serves to inform the contractor where he needs to correct foundry or welding practice. When production shipments arrive, they test 10% selected at random. If these are sound, it is reasonable to assume the whole shipment is satisfactory. However, if some are found defective, another 10% is examined until they are satisfied as to accepting or rejecting the

shipment. Some are even checked with Radium or by Gamma Ray Inspection.

The Heat Treatment Department of the Laboratory is a very complete unit in itself, consisting of both electric and gas furnaces capable of controlled temperatures from 1100° -2600°F. Each has a source of controlled atomsphere. The two electric furnaces use a "Drycolene" type of neutral atmosphere, and the gas furnaces use the products of combustion of a variable mixture of gas and air. The two draw or temper furnaces furnish adequate means of temperizing and one has a controllable rate of heating as well as the ability to hold temperature within a range of less than one degree. Besides the usual parafine oil, water, and brine quenches special "doped up" oils are kept for special purposes, as are also other special quenches. Although there is only one salt pot furnace, pots of various salt mixtures are kept and can be readily exchanged to suit the purpose.

There is a "Rockwell Delatometer" for the determination of the critical points of the steel as well as its expansion and contraction on heating and cooling. This apparatus has been used for many things; for instance the determination of cooling efficiencies of different oils at various temperatures. A thermocouple checking furnace can also be adapted to that type of research work where a precise slow or fast heat rate is required.

IN THE LABORATORY the personel is especially proud of the new high frequency unit which generates a current of about 250,000 cycles per second by means of spark gaps. This high frequency current is led around the metallic object to be treated by means of a single or a multi-turned coil of copper tubing. Water is circulated through this tube to keep it cool. The coil heats the object it surrounds by means of the object's resistance to the induced eddy currents and quickly raises the temperature on the surface of the object to a bright red heat. This heating only takes a matter of seconds and a built in timing device regulates the heat treating cycle once the requirements have been determined by experience. The use of this type of heat treatment is especially suitable to local hardening of steel, although through the use of different types of coils it can be used for brazing, soldering, and melting of metals.

In conjunction with the heat treating department is a small foundry with two high frequency furnaces. One is used for ferrous melting and will hold about 200 pounds. The other is used for non-ferrous melting and its crucible will hold about 150 lbs. of metal. The high frequency current for these furnaces is motor generated and has 3000 cycles per second. These furnaces are used for the compounding of different alloys and the melting of valuable non-ferrous scrap into suitable ingots.

THE DEPARTMENT also has three portable potentic-meters; one to measure milliamperes of a thermocouple, the other two are the bridge balancing type to measure and record the temperature of the thermocouple.

The chemical laboratory has serveral different functions which for the most part are these:

(a) Testing of purchased materials for compliance with specifications. These may either be basic materials which are to fabricated or may be finished products ready for use.

(b) Control of processes in operation such as cleaning, plating, parkerizing, penetration, and salt bath carburizing.

By far the most work falls into various groups; however, many things are tested which cannot be so classified. There groups are:—

(a) Ferrous alloys—i. e., iron and steel

(b) Non-ferrous alloys—i. e., aluminum, copper, bearing metal, etc.

(c) Organic materials which are used in various ways: such as neats-foot oil, linseed oil, castor oil, alcohol, tallow, leather, soap and other detergents, rubber, petroleum products, paint, and also varnish materials.

(d) Among some of the things not classified above but tested are compressed nitrogen gas for recoil mechanisms and ignition cable for tank motors.

THE SPECTROGRAPHIC analysis department has an important place closely allied to the chemical laboratory and rightly so

because by this method they can do the following three things:—

1.—Make quantitative routine steel analysis which saves a great deal of time for the other chemical laboratory.

2.—Make final analysis on some non-ferrous material, quantitatively.

3.—Make a "qualitative" determination of anything so desired by the other laboratory so they will have an idea of what to look for.

Ten samples are exposed on one strip of film fourteen or fifteen inches long and thirty-five milli-meters wide.

IN THE TESTING of petroleum products, the laboratory covers a very wide range of materials. The following is a list of various products that have been tested: all types of light napthas, paint thinners, cleaning solvents, gasolines, kerosene, heating fuel oils, diesel fuel oils, very light machine oils, penetrating oils, machine and automotive lubricating oils, recoil oils, heavy steam cylinder oils, diesel lubricating oils, compounded lubricating oils, aircraft lubricating oils, rust preventive oils, slushing oils, animal and vegetable oils, (lard, sperm, neatsfoots, linseed, etc.) quenching oils, hydraulic oils, extreme pressure oils, soluble cutting oils, compounded cutting oils, (sulphurized, chlorinated, etc.) road oils, graphited oils, gear lubricants, petrolatum, rust preventives, greases (cup, wheel bearing, chassis, graphited, recoil, starter and generator, special high melting point, etc.)

A WIDE VARIETY of tests must be performed by the laboratory. Some of these are: color of lubricating oils, cloud and pour point, viscosity, viscosity index, penetration, specific-gravity, distillation, flash point, fire point, vapor pressure, melting point, water determination, sediment, precipitation number, emulsion, and emulsibility tests, oxidation tests, protection tests, carbon residue, acidity, sulfur, corrosion, saponification tests, iodine number, oil separation from grease, ash, soap content, octane number, etc. including probably a dozen other minor tests. Some special tests are also made on some petroleum products—tests that might be developed.

X-ray diffraction patterns are now made on many things by one of the three methods: *Transmission*, which is used to determine the strains in thin pieces of metals; *reflection*, which gives the degree of forging and the orientation of crystals; and *powder* which is used to check the chemical analysis of compounds present if they are crystalline.

ONE OF THESE is a plasticity number or low temperature torque which they use to test grease. The torque or load times the time gives the plasticity number. *Oxidation stability* measures the rate of oxidation adsorption. *Bleeding* is another test which uses a nickel filter cone that separates and evaporates oil at elevated temperatures.

In the paint laboratory, all paints are checked for drying time, color, and chemical analysis. The varnish vehicle of the phenolic type paints are tests for water, gasoline, and oil resistance. Glyceral phthalate type varnish paints are analyzed for percent of phthalic anhydride and for compliance with Quartermaster's Specifications.

In the rubber laboratory, natural, reclaimed, and synthetic rubber are all treated and experimented with by giving some of the following tests: tensile, elongation, modulus, set, accelerated aging, oxygen bomb, hardness, elasticity, compression set, adhesion, abrasion, flexometer, silver corrosion, specific gravity, rubber by volume, oil absorbtion, besides other tests which are special and which are used for only certain products.

IN THE TEXTILE and paper laboratory there is a constant temperature room which is kept at 70°F with a relative humidity of 50% for paper and 65% for textile testing. Some of the tests on paper are as follows: tensile, 0-10 lbs. on one machine and 0-10,000 lbs. on another, weight, bursting strength, folding strength, opaqueness, water permeability, turpentine test for oiled or waxed paper, rosin, ash, acidity, paraffin, fading, p-H, etc.

In 1934, research was begun on oils, cleaning and preserving materials. Since that date problems on rubber, lether, and recuperator springs have been assigned; others have been added from time to time, such as the

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SPIDER SILK

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was making better instruments than those which they brought with them. Twenty-three years later this instrument maker, David Rittenhouse, was the first to use spider silk as cross hairs to mark the optical center of his telescope in his transit instruments. His priority in regard to this useful invention was acknowledged by E. Traughton, the famous instrument maker of England, who brought spider silk lines into universal use in astronomical instruments. They have been used for that purpose ever since, and no other fibers, either natural or artificial, has been found to be superior to them.

THE USEFULNESS of spider silk as cross-lines depends upon several factors; their fineness, uniformity, strength and ability to withstand great changes in humidity and temperature. While the silk of all spiders might appear to the casual observer to be very much alike, great differences are observed on careful examination in the laboratory. Only two or three spiders have been found whose silk meets the rigid requirements of the astronomer and optical instrument builder. They are all *orb weavers*, producing webs of fine strong threads in which to ensnare and entangle their prey. One of the best of these is the large Golden Garden Spider *Amiranda aurentia*Q, a beautiful black and yellow spider, with a body almost an inch long (female). She spins a beautiful geometrical web swung vertically between the branches of a blackberry or other bush. This web, although fine and almost invisible, is strong enough to support easily the heavy spider or hold the struggling ensnared grasshopper.

In the central United States the golden garden spider reaches maturity about the middle of August. The male spider is small and insignificant, being but a puny dwarf in comparison to the female. He usually spins a small web off to himself; often after mating he is killed and eaten by the female. The silk is taken directly from the female in late summer by *milking*... In this process the spider is held in such a way that she cannot reach the thread with her feet.

THE FIBER is then drawn from her harmlessly and wound on reels which can be kept indefinitely. The silk as drawn from the spider is stranded, consisting of as many as six separate threads, each coming from one of the six nipple-like spinerets arranged in a circle near the posterior end of her abdomen. Although this operation is harmless to the spider, she objects to it very strenuously and will sever the thread with her feet if she has the opportunity. She is powerless, however, to prevent the drawing of the threads from her spinnerets once they have been started; this is accomplished by gently rubbing a tooth pick over the spinner-ets. As many as ten or eleven 50 ft. reels have been taken from a full grown female at one milking. The sticky fuid from the spider's spinnerets hardens rapidly when exposed to the air. The silk is wound on convenient reels in length of 50 or 100 feet, and stored in dust proof containers; it can be preserved indefinitely.

0.0001 in. Diameter

The silk taken from the Golden Garden Spider has a diameter of about 0.0001 inches or 2.5 microns. Under the microscope it appears solid, almost completely transparent without any internal structure, of approximately circular cross section and uniform in diameter. It has a specific gravity of about 1.30 to 1.37 and an ultimate breaking strength of about 60,000 lb. per sq. in. It has a considerable amount of elasticity, but also shows some flow properties. It continues to be extended under a constant stress for some time but recovers upon the removal of the stress.

A CENTURY AND a half of use as cross lines has tested the reliability of spider silk, its ability to withstand changes in temperature and humidity, and its ability to withstand oxidation, the bane of artificial and metal fibers when used as cross lines. In many installations spider lines have been known to last more than half a century, often outlasting the instruments themselves.

Spider silk is not surrounded by an enveloping substance like the sericine of ordinary

silk. In microchemical tests it is shown to be similar in composition to true silk.

According to Fischer[1] spider silk gave the following products when hydrolized with acid:

Glycocoll	25.13
d-alanine	23.40
l-leucine	1.76
Proline	3.68
l-tyrosine	8.20
d-glutaminic acid	11.70
Diomino acids	5.24
Ammonia	1.16
Fatty acids	0.59

Glutaminic acid, which is present in rather a large amount in spider silk, has not often been found in ordinary silk. Spider silk, on ignition, gave 0.59 percent of ash.

In very humid atmosphere the silk absorbs moisture. This causes the cross lines in the surveyor's transit to sag when water gets into the telescope, however their tautness is restored on drying out the telescope.

How Hairs Are Installed

TO INSTALL the cross hairs in an optical instrument requires some skill and patience. This work should be done under a strong illumination, and over a dead black background such as that afforded by black velvet cloth. In the instrument, the cross hairs are usually mounted upon a removable ring or reticle; in the cheaper instruments this ring is often held by friction, but in transits and levels used in surveying they are held by four capstan screws. The ring must be removed and thoroughly cleaned of the cement used to fasten the old cross hairs. The old cement can be removed by the use of alcohol or amylacetate depending upon whether shellac or a plastic cement was used. On the ring will usually be found fine scratches or lines used to define the position of the hairs. On cleaning the ring, care should be taken not to disturb or mar these scratches.

In order to facilitate the handling of the fiber of spider silk a hair pin shaped piece fine and have been put on the ring with precision by means of a dividing engine or an engine lathe.

1—Zeit, physiol. Chem., 1907, p. 126.

of brass wire is used; the two prongs being apart about twice the diameter of the reticle upon which the cross-hairs are to be mounted. The ends of the prongs are dipped into *Duco* cement to render them tacky. They are then inserted under one of the strands on the reel and on being lifted up, the strand of spider silk will be found adhering to them and stretching from prong to prong. This strand will very likely be composed of several fibers of the silk; only one is wanted. A convenient tool for separating the fibers consists of a fine needle mounted in a long handle similar to that of a fine camel hair brush. Holding the brass hair pin or wire frame with the strand of spider silk taut from prong to prong under the bright light and over the black velvet with the left hand the needle is inserted through the strand of silk with the right and with a sidewise motion all the fibers on one side of the needle are broken, whereupon this operation is repeated until only a single fiber is left.

A Delicate Job

THE WIRE FRAME is then laid down so that the taut fiber of spider silk lies across the reticle in the desired position and the other end of the wire frame rests on the table. The fiber should support the weight of the prongs of the wire frame thus stretching it tightly across the reticle. If the fiber does not rest in the grooves or scratches intended for it, it can be gently eased into position by use of the long handled needle, care being taken that the sharp edges of the reticle do not cut the fiber.

When the fiber is in place it can be cemented by placing a tiny drop of shellac or *Duco* cement on either end. The fiber and reticle must not be disturbed until the cement has set after which the superfluous fiber can be cut away with a small sharp pair of embroidery or cuticle scissors. The rest of the cross-hairs are placed on the reticle in the same way following the pattern as laid out in the grooves or scratches. Patience and care are essential, especially when two or more cross-hairs are mounted on the same reticle, but if one does not hurry or become impatient, he will be surprised at the ease with which this difficult task can be per-

Governing Rules of the National Science Teachers Association

The By-Laws adopted April 1-2, 1944, in Pittsburgh, Pa., were, for the most part, of a temporary character; effective only until a more permanent set could be formulated and adopted. The following Governing Rules; including Constitution, By-laws, Rules, and Enabling Clauses, were approved by the Board of Directors at the Cleveland, Ohio, meeting, Sept. 15-17, 1944.

CONSTITUTION

Article I
Name and Affiliations

Section 1.
This organization shall be known as the National Science Teachers Association.

Section 2.
This organization of science teachers shall be an affiliate of the American Association for the Advancement of Science and a department of the National Education Association. Through cooperating organizations it shall have official connections with other scientific and professional groups.

Section 3.
The letters N. S. T. A. as hereinafter used shall mean this single general organization of science teachers.

Article II
Purposes

Section 1.
The general purpose of the National Science Teachers Association shall be to stimulate, improve, and coordinate science teaching at elementary, secondary, and collegiate levels of instruction.

Section 2.
The general aims which are to be pursued in attempts to achieve the general purpose are as follows:

(a) To make the influence of science teacher organizations a potent force through the unification of their efforts.

(b) To initiate and maintain a national effort by scientists and educators to the end that the sciences may be given a just and reasonable opportunity to serve the needs of all youth and adults.

(c) To plan a long range program for the improvement of science teaching.

(d) To assist scientists and science teachers to work together and have a voice along with other groups, such as teachers in other subject matter fields, supervisors, and administrators in defining plans and policies for public education.

(e) To stimulate widespread and intelligent cooperative action on problems related to science teaching.

Article III
Membership

Section 1.
The qualifications, classifications, and rights of members shall be as defined in the By-Laws.

Article IV
Officers and Duties

Section 1.
The officers of the N.S.T.A. shall consist of a president, one or more vice-presidents, a secretary, a board of directors, and such other officers as shall be prescribed in the By-Laws.

Section 2.
The powers and duties of officers and directors together with the method of their election shall be as prescribed in the By-Laws.

Article V
Amendments

Section 1.
Amendments to this constitution shall be made by a two-thirds vote of the board of directors and subject to such requirements as may be prescribed in the By-Laws.

Article I
Location

Section 1.
The headquarters of the N.S.T.A. shall be in the offices of the National Education Association, 1201 16th Street,N. W., Washington, D. C.

Section 2.
Additional or other offices of the Association may be established by the Board of Directors.

Article II
Membership

Section 1.
Individual persons and groups interested in promoting the aims of the Association are qualified for membership.

A. *Individual*

1. Active: Persons who qualify for membership may become active members in the N.S.T.A. by an annual payment of $1.00 to the treasurer. Four publications and a yearbook shall be delivered to all active members. The services of the national headquarters shall be available directly to all active members. Active members may purchase all special bulletins and reports at a discount.
2. Sustaining: Qualified persons may become members of N.S.T.A. as sustaining members by an annual payment of $5.00 or more to the treasurer. Sustaining members shall receive four publications, the yearbook, and all special bulletins and reports of the N.S.T.A.
3. Life: Any person qualified for membership may become a life member by the payment of $150 to the treasurer. This payment may be made in one lump sum or in annual payments of not less than $15.00. Life members shall receive all publications of the N.S.T.A.

B. *Group*

1. Affiliated Group: Any organized group of individuals interested primarily in science in its relation to education is eligible for this class of group membership. The annual dues shall be $2.00 for groups having 50 or more members. Smaller groups are eligible for membership without payment of dues. All groups shall file their application for group membership with the president of the N.S.T.A. Affiliated organizations shall retain their autonomy.
2. Institutional Members: Any organization or institution interested in science in its relation to education is eligible for this class of membership. The annual dues shall be $50.00 or more payable in one sum.

Section 2.
The membership year for all members shall be from November 1 to October 31.

Section 3.
All Active, Sustaining and Life members have the right to vote and hold office.

Article III

Officers, Boards, Sections and Committees

Section 1.
The officers of the N.S.T.A. shall be a president, two general and four regional vice-presidents, a corresponding secretary, a recording secretary, and a treasurer.

Section 2.
The Board of Directors shall consist of the elected officers provided for in section 1 together with not exceeding fifteen persons elected at large from the Association.

Section 3.
The Board of Directors may select one or more executive secretaries to give part or full time service to the national headquarters and related responsibilities.

Section 4.
The Executive Committee of the N.S.T.A. shall consist of the officers and the executive secretary.

Section 5.
Groups of members having a common interest in a special phase of science may form a "*Section*" with the approval of the Board of Directors.

Section 6.
Affiliated groups may be represented by one consultant for each 100 members, or fraction thereof, of the affiliated group.

Section 7.
The standing committees of the Association shall be: Nominations, Resolutions, Year Book, Program, Budget, Auditing, Professional Realtions, and Public Relations.

Section 8.
Special committees may be established by the President of the Board of Directors or by resolution of the members present at a summer or winter meeting.

Article IV

Nominations, Elections, and Voting

Section 1.
Nominations and elections shall be held in accordance with the By-Laws and Rules of the Association.

Section 2.
The term of office for Directors shall be three years. The term of office for officers shall be one year. Officers and Directors shall take office August 1.

Section 3.
An executive secretary may be elected by the Board of Directors for a term of not exceeding six years.

Section 4.
Consultants shall be elected for a term of office determined by the affiliated group.

Section 5.
The standing committees of the Association shall be named by the President. The number and term of service of the members of each committee shall be determined by the Executive Committee.

Section 6.
The number and term of service of the members to be placed upon each special committee shall be as determined by the Board of Directors or by resolution adopted by the members.

Section 7.
Vacancies shall be filled by the Board of Directors until the next regular election after the vacancy occurs.

Section 8.
The election of the officers and directors of the N.S.T.A. shall be by mail ballot to the individual members.

Section 9.
Questions of policy may be submitted to the members by mail ballot if so directed by resolution of the Association in meetings or resolution of the Board of Directors.

Section 10.
Election of Officers and Directors shall be completed by May 10 of each year.

Section 11.
The Board of Directors may take action by mail or telegraphic ballot.

Article V

Duties of Officers and Committees

Section 1.
Except as otherwise provided in these By-Laws the duties of the various officers of this Association shall be those which are customary for such officers.

Section 2.
The President shall have general charge of the affairs of the N.S.T.A. He shall prescribe the duties of the Executive Secretary within such limits as may be prescribed by the Board of Directors.

Section 3.
Each regional vice-president shall be a director of membership activities in one major section of the United States. Other duties of each vice-president shall be as defined by the President or by the Board of Directors or by resolution of the Association.

Section 4.
The Board of Directors may select, and determine the tenure of office and salary of one or more executive secretaries to give part or full time service to the national headquarters and related responsibilities.

The Board of Directors shall have the power to prepare and approve budgets, to review the action of subcommittees, to select the major business to be referred to the general membership, and to exercise other powers not assigned to officers.

Section 5.

The recording secretary of the N.S.T.A. shall maintain a record of the official business of the N.S.T.A. and its Board of Directors. He shall prepare an annual report for the general membership.

The corresponding secretary shall perform such duties as may be assigned by the President or the Board of Directors.

Section 6.

The treasurer shall maintain the financial records of the Association with the assistance of the National Education Association as the official depositer. He shall prepare an annual report for the general membership and such additional reports as may be required from time to time by the Board of Directors. He shall authorize payments *only* upon written order of the President. The Board of Directors may require a surety for from the Treasurer.

Section 7.

The Executive Secretary shall, working under the general supervision of the President, endeavor to carry out the policies formulated by the Association in meeting or by the Board of Directors, or by the Executive Committee.

Section 8.

The Consultants shall suggest names for the consideration of the Nominating Committee; shall participate in service projects of the Association; and shall have such other powers and duties as may be assigned to them by the Board of Directors or the President.

Section 9.

The Nominating Committee shall consider suggestions made by Consultants representing affiliated groups and other suggestions when preparing nominations for Officers and Directors.

Article VI

Quorum and Rules of Order

Section 1.

Two-thirds of the Executive Committee shall constitute a quorum for the transaction of business by the Executive Committee.

Section 2.

Two-thirds of the Board of Directors shall constitute a quorum for the transaction of business by the Board of Directors.

Section 3.

Robert's Rules of Order Revised shall govern the conduct of all business meetings of the Board of Directors and the Association.

Article VII

Amendments

Section 1.

Amendment to the Constitution shall be made when—

a. The proposal has been sent to the members through the offical journal at least sixty days prior to the meeting of the members at which action may be taken.

b. Approved by two-thirds vote of the members.

c. Approved by a vote of two-thirds of the entire membership of the Board of Directors.

Section 2.

Amendments to the By-Laws shall be made when either of the following requirements have been satisfied—

a. 1. The proposal has been sent to the members through the official journal at least sixty days prior to the time at which action may be taken, and
   2. approved by the members by a two-thirds vote.

or

b. 1. approved by members by majority vote and
   2. approved by Board of Directors by two-thirds vote.

Section 3.

Amendments to Rules may be made by a majority vote of the Board of Directors.

RULES

(No doubt some of these rules may ultimately become a part of the By-laws. For the present they are guides for the officers, subject to amendment by the Board of Directors.)

GENERAL

1. The N.S.T.A. shall consist of one national group of science teachers officially related to major scientific and professional organizations together with the affiliated national, sectional or local groups.
2. The national services which are to be achieved by this organization are the following:
   A. The establishment of a national headquarters for the improvement of science teaching.
   B. The selection of a properly qualified staff for the national headquarters including one or more executive secretaries.
   C. The development of a plan of a widespread service to teachers through groups that maintain cooperative relations with the N.S.T.A.

MEETINGS

3. The Board of Directors shall hold its annual winter meeting at the time and place of the American Association for the Advancement of Science or as determined by the Board of Directors. The summer meeting shall be held at the time and place of the National Education Association. The agenda for each meeting shall be mailed to all members of the Board of Directors at least two weeks in advance.
4. The Executive Committee of the N.S.T.A. shall hold its annual meeting in conjunction with the winter meeting of the Board of Directors. There shall be three other quarterly meetings either by actual attendance or by mail. Reports of these meetings shall be made to the Board of Directors within one month after the date of the meeting.
5. The Board of Directors, through its officers and committees shall provide for a winter and summer meeting of the Association. Such

meeetings shall be planned in cooperaion with the affiliated groups and shall be held at the time and place of the A.A.A.S. and the N.E.A. or as determined by the Board of Directors. Additional general meetings may be held in conjunction with other groups. The N.S.T.A. shall make special efforts to promote attendance at all meetings in which it has a definite place on the program.

SERVICES

6. The members of the Board of Directors and the Executive Secretary shall provide all possible assistance to affiliated groups in the planning of programs, in providing extensive publicity for their meetings, and in such other ways as the Board of Directors may deem proper. Each affiliated organization shall be provided with the information needed to assist other affiliated groups in giving proper publicity to programs and services. The Board of Directors shall arrange for the collection and distribution of such publicity.
7. *The Science Teacher* shall be the official journal of the N.S.T.A.
8. All the affiliated organizations shall have equal access to reports of the N.S.T.A. and they shall be urged to give publicity to such reports. All reports of the N.S.T.A. shall be prepared in full as well as in abstract form. Releases to the public press shall be prepared and distributed. The N.S.T.A. may secure copyrights on the materials and may grant permission for printing to all affiliated organizations.
9. The N.S.T.A. shall secure reprints of each report from one of the publications in which it is printed. Reprints or extra copies of reports shall not be available from the publisher but may be secured from the N.S.T.A. headquarters office at a nominal charge as determined by the Board of Directors or the Executive Committee. When no journal is interested in publishing a report the Board of Directors may make plans for publication and sale of copies.
10. The N.S.T.A. shall develop and maintain cordial relations with other professional and scientific organizations so as to assist, by the selection of committee members and consultants, in all projects which may have a bearing on science teaching. Furthermore, the N.S.T.A. shall plan and initiate projects which give promise of improving science teaching and the place of science instruction in the education of youth. The N.S.T.A. shall endeavor to enlist the assistance of scientific and professional groups as necessary for the successful development of such projects.
11. The N.S.T.A. shall endeavor to arrange club rates in order that science teachers may secure the services of two or more organizations or publications at a reduced cost. Club rates shall be included in the publicity arranged by the Board of Directors.
12. The N.S.T.A. shall assist in bringing free and low-cost services to the attention of science teachers.

FINANCES

13. The Board of Directors of the N.S.T.A. shall make immediate plans for grants-in-aid. Aid shall be sought for the support of projects which have the approval of the Board of Directors. The establishment of the N.S.T.A. is to be regarded as one project for which a substantial grant-in-aid is to be sought. The acceptance and allocation of financial aid as secured shall be under the general control of the Board of Directors.
14. Dues from individual and group memberships shall constitute another major source of income for the N.S.T.A.
15. The sale of reprints or reports shall constitute another source of income. While reports may be available to science teachers and other persons through established magazines in which they are printed, they will be available to others at a nominal charge through the headquarters office.
16. The N. S. T. A. shall arrange for publications to carry reports and for other information of assistance to science teachers and to the affiliated organizations. Income from advertising will help to support the publications. Any publication which is arranged should be so planned that it will be of genuine value to science teachers. It shall supplement rather than compete with other publications.
17. The Board of Directors shall encourage persons or groups to make direct gifts or endowments to the N.S.T.A.

ORIGIN OF AMENDMENTS

18. Proposal of amendments to the Governing Rules may originate in—
    a. Communications signed by five or more members.
    b. Communications from an affiliated group
    c. The Board of Directors
    d. Summer, winter or special meetings of members.

REGIONS

19. Regional vice-presidents shall represent the following groups of states and territories:
    Eastern Region—Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont.
    North Central Region—Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin.
    Southern Region—Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, Texas, Virginia, West Virginia.
    Western Region—Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming.

ENABLING CLAUSES

Section 1.

The following officers and directors shall serve until August 1, 1945:

President: Philip G. Johnson, Cornell University, Ithaca, N. Y.

General Vice-Presidents:

Norman R. D. Jones, Southwest High School, St. Louis, Mo.

Morris Meister, Bronx High School of Science, New York, N. Y.

Regional Vice-Presidents:

W. Bayard Buckham, 50 Buckeye Ave., Oakland, Calif. (Western)

Fred W. Moore, Senior High School, Owosso, Mich. (N. Central)

Greta Oppe, Ball High School, Galveston, Texas (Southern)

Ethel Ramsden, State Teachers College, Montclair, N. J. (Eastern)

Recording Secretary:

Deborah Russell, State Teachers College, Framingham, Mass.

Corresponding Secretary:

Nathan A. Neal, Division of Instruction, Board of Education, Cleveland, Ohio.

Treasurer:

Hugh C. Muldoon, Duquesne University, Pittsburgh, Pa.

Directors:

Maurice U. Ames, New York City Federation of Science Clubs.

Florence Billig, National Association for Research in Science Teaching.

John C. Hogg, New England Chemistry Teachers Association.

Emil L. Massey, Central Association of Science and Mathematics Teachers.

W. H. Michener, American Association of Physics Teachers.

Hugh C. Muldoon, Duquesne University Conference for Science Teachers in Catholic High Schools.

Laurence L. Quill, Division of Chemical Education, American Chemical Society.

Merl A. Russell, National Association of Biology Teachers.

Reuben T. Shaw, Middle States Association of Science Teachers.

Dwight E. Sollberger, American Nature Study Society.

Paul R. Young, Garden Education Section, N. S. T. A.

Provided, however, that this Board may add to its membership not exceeding five members and fill any vacancies by approving changes proposed by a group or by direct action, where necessary.

Section 2.

In order to establish a plan of overlapping terms the Directors elected in 1945 shall determine who shall serve for one-year terms, who shall serve for two-year terms, and who shall serve for three-year terms.

Section 3.

The Governing Rules of the N. S. T. A. including the Constitution, By-laws and Rules shall be printed as early as possible in the official journal of the Association.

Section 4.

Members are urged to study these materials carefully and send proposed changes to the President of the Association not later than February 1, 1945.

Section 5.

Proposed changes that thus come in shall be submitted to the Board of Directors by mail and such as may be approved by the Board shall be printed in the April issue of the official journal.

Section 6.

As soon as the Governing rules are adopted by the members, these enabling clauses shall be deleted therefrom.

WRITE FOR IT

In writing to any company listed below for free or inexpensive materials use your school letter head or stationery. The material is for the teacher only, unless otherwise stated.

Aluminum Company of America, 801 Gulf Building, Pittsburgh 19, Pa.

Booklets:

Aluminum—Its Story.

Aluminum in the Chemical Industry.

An Outline of Aluminum.

Bausch and Lomb Optical Company, Rochester 2, N. Y.

Booklets:

Educational Focus.

Use and Care of the Microscope.

Microscope Equipment for the Amateur.

Miscroscope Experiments. Book I. 75¢.

Microscope Experiments. Book II. 75¢.

Bausch and Lomb Science Award Booklet.

Scholarship Booklet:

Wall Charts:

The Path of Light through the Microscope.

The Colorimeter

Pictures: (a series)

Milestones in Optical History (Suitable for framing)

General Biological Supply House, 761 East 69th Place, Chicago 37, Illinois.

Booklets:

Turtox Teachers' Manual (for high school biology and other introductory courses in botany and zoology)

Turtox News.

Leaflets: (a series, 1-52. Write for complete list.)

No. 1. How to Make an Insect Collection.

No. 4. The Care of Protozoan Cultures in the Laboratory.

No. 34. How to Maintain Living Material in the Laboratory to Demonstrate Different Types of Insect Life Cycles.

No. 48. Aquarium Troubles: Their Prevention and Remedies.

General Electric Company, Publicity Division, Schenectady, N. Y.

Booklets:

The Romance of Electricity.

News Digest (published bi-monthly)

FERROUS HYDROXIDE

J. C. AMON

Geo. Westinghouse High School, Pittsburgh, Pa.

BECAUSE of the readiness with which ferrous hydroxide oxidizes to ferric hydroxide, it is often quite difficult to prepare it in sufficient quantity to demonstrate to a class that it is white, especially if the usual procedure of adding a soluble base to a solution of a ferrous salt is followed. The following method will give very satisfactory results and produce the white hydroxide in considerable quantity.

PREPARE ferrous chloride in the usual manner by treating iron filings with hydrochloric acid and then filter into a test tube about one fourth or one third full of concentrated ammonium hydroxide. Place the funnel so that the stem is well down inside the test tube. Since the ferrous chloride solution passes through an atmosphere of ammonia gas, little or no oxidation takes place and a heavy precipitate of the white hydroxide is easily obtained.

STATEMENT OF OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933

★

Of *The Science Teacher*, published 4 times per year at Normal, Illinois, for October, 1943.

STATE OF ILLINOIS, County of McLean, ss.

Before me, a notary public in and for the State and county aforesaid, personally appeared John C. Chiddix, who, having been duly sworn according to law, deposes and says that he is the owner of *The Science Teacher* and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodeid in section 537, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher—John C. Chiddix, Normal, Illinois.

Editor—John C. Chiddix, Normal, Illinois.

Managing Editor—None.

Business Manager—John C. Chiddix, Normal, Illinois.

2. That the owner is: John C. Chiddix.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent of total amount of bonds, mortgages, or other securities are: none.

JOHN C. CHIDDIX.

Sworn to and subscribed before me this 11th day of October, 1944.

(SEAL) (My commission expires, Jan. 18, 1945.)

Ethel Pace.

X-RAY

Continued from page 9

from the foregoing results depending on crystal structure and chemical composition. Sharp diffraction lines are found over a range of sizes from 10^{-4} to 10^{-6} cm. For grains larger than this spots appear, becoming larger and fewer in number the larger the size. For particles smaller than 10^{-6} cm. the lines become increasingly broader as size diminishes, so that measuement of the broadening leads to particle size. Even the shape of the particle may also be deduced from the broadening in different directions. It should be noted that X-rays give results on *primary* crystal particles only, and not on secondary aggregation of any kind. This size and shape measurement is, of course, of immediate importance for all kinds of pigments and fillers, where covering power is at issue; for catalysts such as magnesium oxide; for polishes determined quickly and unequivocally information on the completeness of calcination of calcite, dolomite, or magnesite to CaO, CaO + MgO, or MgO respectively; the rate of hydration of these to the corresponding hydroxides, and the effectiveness of autoclaves in hydrating the MgO; the chemical changes in setting of plasters and mortars (chiefly recarbonation). Thus in some very old dolomotic plasters unchanged MgO may be found. The temperature of original burning determines the ease of hydration of the resulting oxide; if this is done at the lowest possible temperature, MgO will easily react with water, while at very high temperatures of burning, it will become refractory and resist hydration even with steam under pressure. Similarly reactions of limes in Bordeaux (copper sulfate) and arsenate insecticide sprays gives a complete picture of the chemical reactions involved, another aspect being the uptake of magnesium from sprays containing dolomotic lime to correct nutritional deficiency.

REMARKABLE results on various combinations of phosphates, carbonates and silicates in detergents and baking powders are too numerous to present. Suffice it to say that several patents are based directly upon X-ray diffraction proof of double-salt or new compound formation. Another interesting field is the differentiation of a product obtained by *incipient* fusion or sintering and complete fusion. The former are crystalline, the latter usually in the glassy state. Determination of true hydrates vs. physically bound or absorbed water has been involved in a considerable number of industrial chemicals. The stability of various salts and hydrates as a function of temperature, hydrolysis in solution and other factors is required information in many cases, and is easily shown by the pattern. The unique reaction between basic acid, sorbicylic acid and zinc sulfate to yield a powerful antiseptic and burn treatment could be demonstrated only by the X-ray pattern as completely different from that of any constituent.

4. To measure and control particle size. As indicated previously, the X-ray diffraction pattern may be used to evaluate primary particle size in a specimen, entirely apart from the foregoing results depending on crystal structure and chemical composition. Sharp diffraction lines are found over a range of size from 10^{-4} to 10^{-6} cm. The grains larger than these spots appear, becoming larger and fewer in number the larger the size. For particles smaller than 10^{-6} cm. the lines become increasingly broader as size diminishes, so that measurement of the broadening leads to particle size. Even the shape of the particle may also be deduced from the broadening in different directions. It should be noted that X-rays give results on *primary* crystal particles only, and not on secondary aggregation of any kind. This size and shape measurement is, of course, of immediate importance for all kinds of pigments and fillers, where covering power is at issue; for catalysts such as magnesium oxide; for polishes and rouges; and, in fact, for any product when colloidal size is required, or when size is a determining factor in performance. The advent of the electron microscope and direct measurement of sizes at high magnifications have completely verified the older X-ray diffraction method. A special case is that of the carbon blacks, cokes and charcoals, all of which are more or less imperfectly organized groups of carbon atoms which finally become three-dimensionally crystalline graphite. A knowledge of the infinite variety of intermediate steps in organization and of particle sizes has been made possible only by X-ray analysis. Production in this enormous industry is, therefore, based upon, and the product controlled by, diffraction patterns; for recently a type of carbon used in dry cells, no longer available in this country, was reproduced exactly with this aid.

These are but a few examples, chosen at random, of applications of X-ray diffraction research and testing, in the wartime chemical industry. But, fortunately, they are also contributing aids of no inconsiderable value, in an expanded and vigorous peacetime chemical industry.

FLYING

Continued from page 18

can get along very well without these courses.

What the soldier really needs is to be thoroughly grounded in the fundamentals of addition, subtraction, multiplication, division, per cents, fractions and decimals. He also needs the ability to solve practical quantitative problems effectively, confidently, and with common sense. One of the weaknesses in soldiers, which is common to most people, is that they are unable to apply what they know in practical situations. Perhaps every arithmetic problem should teach a fact as well as teach a principle. Should additional time be available, other material in mathematics would prove of benefit, such as estimation of distances, heights, speeds, weights, angles, numbers, area, volume, and temperature. Likewise, the study of the compass, meters, guages, dials, blue prints, graphs, charts, tables, and perhaps simple formulas would be very much worth-while.

FAILURES by students in the study of mathematics are caused by many factors. Among them are, (1) the material presented is above their present ability to absorb, (2) the pupils have not been sufficiently motivated. One principal recently commented that he had put in a course of Review Mathematics and found to his amazement that it turned out to be a first exposure rather than a review course.

Perhaps in mathematics, as well as in other subjects, the material should be presented on various levels according to the ability of the student.

The matter of motivation presents a rather difficult problem at times. A teacher should take time to explain to the students the practical value of what is being presented and to answer all honest questions as to its use and importance.

World War I found us short on the industrial techniques and, in general, in personnel adequately trained in chemistry. Since that time, our expanding chemical industries have given chemistry a popularity that it has maintained. The courses as now taught, with some additional material and changes in emphasis, are meeting the present needs.

The subject of Biology is quite generally well taught. Perhaps additional stress on insect carrying diseases would be very much to the point at the present time.

THE SUBJECT of Physics, in spite of the fact that great progress has been made in transportation and communication, especially in the realm of new electronic devices, has not been a popular one in schools. For example, in 1890 nineteen per cent of the students took the course in physics; in 1934 this per cent had dropped to 6.3. The present situation calls for a great number of people trained in this subject. The manner in which physics was usually taught was acceptable only for those who were preparing for college. In other words, it was abstract, impractical, and theoretical. The present need is to continue the course as previously taught with a war slant added. A course that is more concrete, practical with greater stress on practical electricity and mechanics should also be taught for the great mass of students who are mechanically inclined. The material presented should contain less mathematics and more practical shop or laboratory work.

It is not my intention to leave any one with the idea that the Army feels that higher mathematics and theoretical physics should not be taught. Those who have the capacity to carry these subjects to advantage should be encouraged to do so. We need highly trained specialists who are well educated from every point of view.

It might be well for every teacher to keep in mind that in addition to subject matter as such every soldier should have the following: (1) should feel that this is his fight; (2) should be prepared for Army life; (3) should be physically fit; (4) should have command of basic language skills; and (5) should have vocational or manipulative abilities which will enable him to handle a specialized job.

HOW TO ILLUSTRATE

Continued from page 26

Space fallen= $\frac{1}{2}gt^2=\frac{1}{2}$ times 32 ft/sec/sec times 1 second squared=16 ft.

Height at end of 1 second equals 64 ft. minus 16 ft.=48 ft.

P.E.=M times h=10 pounds times 48 ft.= 480 foot pounds.

Add kinetic and potential energy and we have 160 foot pounds plus 480 foot pounds gives 640 foot pounds, or an amount exactly equal to the potential energy at the beginning of the fall. Let us now find the sum of the potential and kinetic energy at the end of 2 seconds by substituting in the formula, $S=\frac{1}{2}gt^2$.

$S=\frac{1}{2}$ times 32 ft/sec/sec times 2 sec times 2 sec=64 ft.

V=gt= 32 ft/sec/sec times 2 sec=64 ft/sec.

$$K.E.=\frac{mv^2}{2g}=\frac{10 \text{ lb x } 64 \text{ ft/sec / } 64 \text{ ft/sec}}{2 \text{ x } 32 \text{ ft/sec/sec}}$$

=640 ft lbs.

P.E.=M times h=10 lbs times 0 ft=0 ft lbs.

The elevation is zero because the mass has fallen the total distance of 64 ft.

K.E. plus P.E.=640 ft lbs plus 0 ft lbs=640 ft lbs.

Thus is can be seen that the sum of the potential and kinetic energy is constant. This is in accord with the Law of Conservation of Energy.

The examples above are representative of a still larger number of cases that might be used to illustrate just this one important general law in physics.

Airlines War Training Institute, 1740 G Street N. W., Washington, D. C., have issued a number of useful traiinng bulletins. The ones of special interest to high school science teachers would be: Survival, Of Instruments and Things, and Attitude. A charge of 50 cents is made for the larger one and the others are somewhat less. You will find them of interest to your students and you will enjoy them yourself.

HEALTH EDUCATION

Continued from page 21

homes, clothing, hands, and face, as means to reduce illness and consequent loss of time in school or other productive employment?

22. Are you encouraging your pupils to actually grow gardens both for the joy of the activities and as a means for including optimum amounts of fruits and vegetables in their diet?

23. Are your students given substantial instruction related to human genetics coupled with a discussion of the factors which make for a happy life with persons of the same or of the opposite sex?

24. Does your planning include an objective evaluation of results; including growth in knowledges, skills and attitudes, as a phase of the course and given at such a time as to allow for the reteaching of crucial materials and practices?

The members of the health education committees were: Nelson Beeler, Nyack, N. Y., Paul F. Brandwein, New York, N. Y., Philip G. Johnson, (Chairman) Ithaca, N. Y.; Norman R. D. Jones, St. Louis, Mo.; M. A. Russell, Royal Oak, Mich.

METRIC SYSTEM

Continued from page 13

Many organizations have gone on record unanimously favoring the metric system; note the resolution appearing elsewhere in this magazine.

The cost of changing over has been shown to be self-liquidating in many industries. Postwar retooling needs will further reduce costs, and time could be allowed—say ten years—for all of the United States to complete the change.

Many units are near enough our present ones to make the change easy, and standard conversion tables would speed the change.

Take stock of yourself. Wouldn't YOU save time and bother if we were completely on the metric system?

HAVEN'T we been teaching metric for a long time? Can't we just talk metric to

Continued on next page

everyone, and get this job done now? Congressmen stand ready to help when we are ready. Check your own community, talk with business leaders, sell your pupils, your friends, your neighbors, the idea that progress demands that we of the United States *must* go metric, and the sooner the better.

DEFEAT OF FASCISM

Continued from page 20

tions that provide soil for its growth must be eradicated. The scientist will not shut his eyes to the forces that control and direct the work of science. The policy of Congress as revealed by its attitude towards establishment of a permanent FEPC, the need for extended social security as embodied in the Kilgore-Murray Bill, the role of international cartels in shaping the destinies of people are all of serious concern for the scientist and the science teacher.

The spadework is being done for the groundwork which will guide future world policy. Will the next Congress provide a more progressive lead? Will the Dumbarton-Oaks Conference lay a course for economic and scientific progress? Will the announced resumption of hearings by the Kilgore Subcommittee on War Mobilization, on the effect of cartels on national security, lay a course for proper governmental control?

Teachers of science will observe with active interest.

ALLERGIES INHERITED

Allergy to ragweed or other things is a "matter of inheritance"—but that does not mean that an unfortunate individual is sensitive to the same things a relative is. So stated Dr. Kenneth E. Crounse, in charge of the allergy clinic at Albany Hospital in New York, in a General Electric Science Forum address.

"Perhaps you are allergic to ragweed; your relatives may have been allergic to animals, or foods, or what-not, and having perhaps hives or asthma, instead of hay-fever," said Dr. Crounse.

"The allergic-tendency is inherited by some members of allergic families, the individual person demonstrating any of the manifestations of allergy and from any cause, not necessarily the same manifestation of the same cause. Biology is fickle and confusing at times."

BOOK SHELF

ELECTRICAL ESSENTIALS OF RADIO, Morris Slurzberg and William Osterheld, Dickinson High School and the Evening Technical and Industrial High School, Jersey City. McGraw-Hill Book Company, New York City, 1944. 529 pp. 13x21 cm. Illus. $3.00.

Electrical Essentials of Radio provides the student a broad background of understanding of the electrical principles underlying a knowledge of radio. It is written for people of limited mathematical background and is suited for use in high school, trade, or technical school. With the material here presented in hand a study of radio circuits and the general principles of radio can intelligently be made.

The clear explanations of theory, the use of good illustrations, and the development of mathematical principles as needed should make this book desirable either as a text or as reference for teacher and student.

AIRPLANE ENGINE MECHANICS, Rolla Hubbard, Flight Engineer School, Pan American Airways; and Augustin Dilworth, American Export Airlines. McGraw-Hill Book Company, New York City, 1944. 260 pp. 12x18.5 cm. Illus. $2.25.

Airplane Engine Mechanics consits of a series of questions and answers concerning the airplane engine prepared with a view of preparing the reader or student to meet the requirements for obtaining a Civil Aeronautics Administration airplane engine license. The book is not intended to replace instructional books in this field. It will be valuable to a person for review purposes or study only in introducing him to the problems in the area or to help fix in mind the essential points needed. Each phase of engine operation is taken up in a separate chapter. The questions are based on an aircooled, four-stroke engine.

HEALTH FOR YOU, Katherine Bruderlin Crisp, East High School, Denver, Colorado. J. B. Lippincott Company, Chicago, 1944. 576 pp. 14x20.5 cm. Illus. $1.80.

Health For You is a complete revision of the textbook *Be Healthy* by the same author. The style is direct and clear and should appeal to high school students. Many good pen an dink drawings as well as photographs are used to illustrate the text.

The first three sections of the book deal with personal health, which should appeal to everyone, the fourth section deals with community health and the fifth with safety.

At the beginning of each chapter are questions which pupils often ask about health. The answers to these are found within the chapter. At the end of each chapter suitable activities are listed. A unique feature is the indication of possible associated work in other subject departments of the school.

MORE ACIDS AND BASES, David Davidson, W. F. Luder and others. Journal of Chemical Education, Easton, Pennsylvania, 1944. 79 pp. 12½x20 cm.

The book is a reprint of a series of six articles in the general area of acid-base behavior, including the presentation of some of the more recent theories in regard to them. The chapters included are: "Acids and Bases in Organic Chemistry; The Indicator Method of Classifying Acids and Bases in Qualitative Organic Analysis; Acids and Bases: Their Relationship to Oxidizing and Reducing Agents; Teaching the Electronic Theory of Acids and Bases in the General Chemistry Course; Acid-Base Relationships at Higher Temperatures; and Acids and Bases: A Critical Reevaluation."

AIR NAVIGATION MADE EASY, James F. Naidich, Air Navigation Chairman, Manhattan High School of Aviation Trades. McGraw-Hill Book Company, New York City, 1944. 124 pp. 18x25½ cm. 98 illus. $1.75.

Air Navigation Made Easy provides training in air navigation for the private civilian flier. The basic principles of air piloting and dead reckoning are covered. It shows how to read maps, to fly by landmarks, to measure direction, to use the compass, to correct for wind, etc. No technical background is required.

MATHEMATICS FOR NAVIGATORS, Delwyn Hyatt, U. S. Merchant Marine Academy, Kings Point, N. Y. and Bennett M. Dodson, U. S. Merchant Marine Cadet Basic School, Pass Christian, Miss. McGraw-Hill Book Company, New York City, 1944. 106 pp. 13x19½ cm. 75 drawings. $1.25.

The book is devoted to the mathematical preparation for the study of navigation. It gives a review of arithmetic, algebra, logarithms, plane geometry, and spherical trigonometry that is needed in the study of navigation. Students without a sufficient background of mathematics will find the book helpful in that it presents only the mathematics needed in this field.

MATHEMATICS OF FLIGHT, James Naidich, Chairman, Department of Mathematics, Manhattan High School of Aviation Trades, New York City. McGraw-Hill Book Company, 1943. 409 pp. 15x23 cm. 396 illus. Text edition, $2.20 list.